ANNUAL REPORT

OF THE

STATE ENGINEER AND SURVEYOR

125.880

OF THE

STATE OF NEW YORK,

FOR THE

FISCAL YEAR ENDING SEPTEMBER 30, 1894.

TRANSMITTED TO THE LEGISLATURE JANUARY 26, 1895.

ALBANY:
JAMES B. LYON, STATE PRINTER.
1895.

STATE OF NEW YORK.

No. 89.

IN ASSEMBLY,

JANUARY 25, 1895.

ANNUAL REPORT

OF THE

STATE ENGINEER AND SURVEYOR.

STATE OF NEW YORK:

OFFICE OF THE STATE ENGINEER AND SURVEYOR,
ALBANY, *January* 25, 1895.

To the Honorable the Speaker of the Assembly:

SIR.— I have the honor to transmit my annual report for the fiscal year ending September 30, 1894.

CAMPBELL W. ADAMS,
State Engineer and Surveyor.

ORGANIZATION.

STATE ENGINEER AND SURVEYOR,

CAMPBELL W. ADAMS.

DEPUTY STATE ENGINEER AND SURVEYOR,

HERSCHEL ROBERTS.

EASTERN DIVISION.

Division Engineer........................ DE WITT C. SMITH.
Resident Engineer........................ ALBERT J. HIMES.

MIDDLE DIVISION.

Division Engineer........................ W. H. H. GERE.
Resident Engineer........................ GEORGE A. MORRIS.

WESTERN DIVISION.

Division Engineer........................ JOHN BISGOOD.
Resident Engineer........................ ALFRED T. JONES.

REPORT.

Office of the State Engineer and Surveyor,
Albany, N. Y., *January* 9, 1895.

To the Honorable the Legislature of the State of New York:

I have the honor to submit the following annual report of the work of this department, covering the fiscal year ended September 30, 1894.

The duties intrusted to this department are defined by the Constitution of the State; by numerous provisions of the Revised Statutes, and by laws passed at each session of the Legislature regarding special subjects.

A brief description of the work done during the past fiscal year, and the cost thereof, will be found in the closing pages of this report.

In pursuance of these laws and the Constitution, the State Engineer, by virtue of his office, is a member of:

The Canal Board.

The Board of Commissioners of the Land Office.

The Board of Commissioners of Quarantine.

The State Board of Health.

The Board of Equalization and Assessment.

The Board of Canvassers.

The Greater New York Commission.

The engineering feature of all work intrusted to these several boards and commissions are matters of much importance, affecting the interests of the people of the State in divers ways, and require much attention and professional study, but as each of these bodies will report to the Legislature separately, as to the nature and extent of their work and responsibilities, they are only simply mentioned in this report to indicate the scope of this department.

The most constantly important function of the department has always been and still is, the charge and direction of the engineering service connected with the design, construction, maintenance

and improvement of that great system of artificial internal waterways, owned and maintained by the State of New York, which have so materially aided in creating and maintaining that proud financial and industrial supremacy which this great commonwealth enjoys among the sisterhood of States.

The record of the part played by the construction and operation of these waterways in the acquisition of such supremacy is an enduring monument to the sagacity, skill, foresight and energy of its promoters and builders, and should always be a matter of native pride and interest. They not only exert a permanent and beneficent influence on the commerce and prosperity of this State, but have been a potent factor in the progress and development of other States, notably those of the great northwest, whose products naturally seek this cheap and convenient route to the seaboard, or are distributed within our borders for consumption or further manufacture, in either case affording remunerative employment to many thousands of our citizens.

No other State possesses a canal system of similar magnitude. First begun in 1791 by the improvement of the connection between the Mohawk river and Lake Ontario, the system has been expanded and enlarged with few interruptions up to the present time. In 1825 the first boat passed from Lake Erie to the Hudson river, and in 1828 the Oswego canal, from Lake Ontario to its junction with the Erie canal at Syracuse was opened. The Champlain canal, from Whitehall, at the foot of Lake Champlain, to its junction with the Erie canal at West Troy, was finished in 1823.

The system to-day comprises about 640 miles of navigable canals, and 84 miles of unnavigable feeders, on all of which there are 261 locks, 33 aqueducts, 1,100 bridges, 93 waste-weirs, 365 culverts, and numerous minor structures, all requiring more or less attention from this department, in connection with their repairs and maintenance. This work is divided between the Eastern, Middle and Western Divisions, each in charge of a division engineer and corps of assistants. A report of work done during the past fiscal year on each division will be found in the succeeding pages hereof, together with recommendations for such minor improvements and repairs as seem to be necessary, and these improvements should not be overlooked because

of the greater improvements now under discussion by the numerous commercial bodies and others interested.

A hurtful opinion seems to exist in the minds of many that the canals are and have been an enormous burden to the taxpayers, but such is not altogether the case, especially if we credit them with even a small part of the increase to our prosperity, for which they are so directly responsible.

It is true that, taken as a whole, they have not earned for the State, directly, a sum equal to the cost of their construction and subsequent maintenance. But it is also true that the Erie and Champlain canals (the accounts of which have always been kept together) show to-day, after 12 years of free canals, a surplus of earnings over cost, of $23,068,911.25.

YEARS.	Tonnage.	Value of tonnage.	Tolls collected.	Payments.		All canals.	Deficiency.	Surplus.
1817 to 1824	....	....	$455,995 38	Canal Commissioners, etc	$90,839,532 42½	Oswego canal	$4,785,778 47	....
1825	....	....	521,848 94	Seneca Lake Navigation Co	53,871 88	Cayuga and Seneca canal	2,001,338 56	....
1826	....	....	844,508 02	Oneida Lake canal and feeder	50,000 00	Chemung canal	3,012,528 59	....
1827	....	....	880,454 09	Contractors	8,147,809 10	Chenango canal	6,197,605 59	....
1828	....	....	829,535 10	Superintendents	32,661,605 15	Crooked Lake	776,918 42	....
1829	....	....	815,239 58	Collectors, etc	3,352,821 59	Black River canal	5,978,008 55	....
1830	....	....	1,042,699 24	Weighmasters	408,046 87	Genesee Valley	8,697,055 60	....
1831	....	....	748,561 29	Miscellaneous	3,371,480 52½	Oneida Lake	610,597 18	....
1832	....	....	1,112,194 74	....	....	Baldwinsville	47,777 62	....
1833	....	....	1,388,055 53	....	....	Oneida River improvement	58,165 45	....
1834	....	....	1,381,951 52	....	....	Erie and Champlain	....	$23,068,911 25
1835	....	....	1,482,963 11	....	....	....	....	....
1836	....	....	1,595,619 48	....	....	....	....	....
1837	1,171,296	$55,809,288	1,824,429 27	....	....	....	....	....
1838	1,333,011	65,746,559	1,464,105 16	....	....	....	....	....
1839	1,435,713	73,399,764	1,653,207 56	....	....	....	....	....
1840	1,416,046	66,308,892	1,602,059 10	....	....	....	....	....
1841	1,521,661	92,202,929	1,987,807 85	....	....	....	....	....
1842	1,236,931	60,016,608	1,795,484 80	....	....	....	....	....
1843	1,513,439	76,276,909	1,952,587 83	....	....	....	....	....
1844	1,816,586	90,821,152	2,386,277 84	....	....	....	....	....
1845	1,977,565	100,629,859	2,374,207 56	....	....	....	....	....
1846	2,268,662	115,612,109	2,788,134 76	....	....	....	....	....
1847	2,869,810	151,563,428	3,460,975 92	....	....	....	....	....
1848	2,796,230	140,086,157	3,153,614 24	....	....	....	....	....
1849	2,894,732	144,732,285	3,377,784 27	....	....	....	....	....
1850	3,076,617	156,397,929	3,390,476 63	....	....	....	....	....
1851	2,582,733	159,981,801	3,702,070 34	....	....	....	....	....
1852	3,863,441	196,603,517	3,173,222 49	....	....	....	....	....
1853	4,247,853	207,179,570	3,161,425 14	....	....	....	....	....
1854	4,165,862	210,284,312	2,980,139 97	....	....	....	....	....
1855	4,022,617	214,390,147	2,631,491 11	....	....	....	....	....
1856	4,116,082	218,327,062	2,719,925 63	....	....	....	....	....
1857	3,344,061	186,997,018	2,529,865 88	....	....	....	....	....
1858	3,665,192	138,568,844	2,045,442 68	....	....	....	....	....
1859	3,781,684	132,160,758	1,812,280 80	....	....	....	....	....
1860	4,650,214	170,849,198	2,379,534 04	....	....	....	....	....
1861	4,507,635	130,115,893	3,353,168 97	....	....	....	....	....
1862	5,598,785	203,234,331	4,790,518 09	....	....	....	....	....
1863	5,557,692	240,046,461	5,028,431 32	....	....	....	....	....
1864	4,852,941	274,400,639	4,808,781 20	....	....	....	....	....
1865	4,729,654	256,237,104	3,516,948 63	....	....	....	....	....
1866	5,775,220	270,963,676	4,248,931 17	....	....	....	....	....
1867	5,688,325	278,956,712	3,992,161 29	....	....	....	....	....
1868	6,442,225	305,301,929	4,417,559 50	....	....	....	....	....
1869	5,859,080	249,281,284	4,112,878 52	....	....	....	....	....
1870	6,173,769	281,336,176	3,080,893 57	....	....	....	....	....
1871	6,467,888	238,767,691	2,818,686 29	....	....	....	....	....
1872	6,673,370	220,918,321	3,060,328 89	....	....	....	....	....

1873	6,364,782	191,715,500	3,021,608 67					
1874	5,804,568	196,674,822	2,921,721 74					
1875	4,859,968	145,008,575	1,902,990 64					
1876	4,172,129	118,080,879	1,477,881 55					
1877	4,955,963	128,938,880	1,041,690 66					
1878	5,171,820	182,264,528	982,243 06					
1879	5,362,872	285,280,726	907,479 95					
1880	6,457,656	247,844,790	1,188,352 74					
1881	5,179,192	162,153,565	810,582 05					
1882	5,467,423	147,918,907	647,602 88					
1883	5,664,056	147,861,228	271,706 49					
1884	5,009,488	162,097,069						
1885	4,731,784	119,536,189						
1886	5,298,982	480,061,846						
1887	5,553,805	159,245,977						
1888	4,942,948	122,524,785						
1889	5,370,369	154,584,222						
1890	5,246,102	145,761,086						
1891	4,568,472	116,269,343						
1892	4,281,995	167,596,948						
1893	4,381,963	154,831,094						
1894	3,882,562	141,179,560						
Total	245,850,581	$9,937,200,776	$134,837,814 26		$143,884,667 04		$32,115,764 08	$23,068,911 25
Deficiency			9,046,852 78					9,046,852 78

2

All the other canals together have cost $32,115,764.03 more than they have earned, so if we deduct from this, the surplus of the Erie and Champlain canals, we shall have $9,046,852.78 of deficit, representing the State's loss on its investment.

But what the indirect influence of the canals has been, on our general status of wealth, importance and population, is of so much vaster importance, that above figures, large as they are, dwindle into insignificance.

On the preceding pages will be found some tabulated statistics, relating to the cost of the several canals to date, together with the amount and value of tonnage transported thereon. This table shows the latter to be nearly $10,000,000,000, and who will say how much of profit has accrued to the people of this State, collectively and individually, from that traffic? The canals should also be credited with the great saving to all industries, which they effect by keeping railroad freight charges within reasonable bounds. The entire annual cost of canal maintenance is unquestionably insignificant, when compared to this saving. Every city and hamlet in the State feels the benefits of the canals to a certain extent, and always on the credit side of the balance sheet. Our "Queen City," of Buffalo, has, largely by the aid of the Erie canal, built up a commerce said to be greater than that of London. Albany and Tonawanda have, by the same means, become the greatest lumber markets of the east, if not of this country. Rochester, Syracuse, Utica, Amsterdam, Schenectady, Troy and hundreds of smaller centers of business activity, wealth and population, as well as the cities and towns along the rivers which form an essential part of the canal system, depend to a great extent for their prosperity on the integrity of the canals, while New York city, reaping a benefit from the growth of all parts of the State, continues to be the most important market and financial center on earth.

Shall we jeopardize such interests as these because of a "penny-wise" policy of economy in canal improvement?

The sentiment of the people, as expressed by their ballots in favor of the amendment for canal improvement at the recent election, emphatically answered this question in the negative, thus clearing the way for comprehensive improvement, which,

it is to be hoped, may soon take on some definite form. When the time comes for a decision as to the extent of these improvements and the amount to be expended therefor, I trust a liberal and broad-minded policy may prevail, and our canals be restored to their former greatness. Such a result is of vital interest, not only to those sections contiguous to the canals, but to every portion of the State, for the canals benefit every portion in many ways. If they increase the wealth of the counties through which they flow, or the terminal cities at which traffic is transshipped, that wealth bears all the burdens of increased taxation. "Statistics prove that in the past seven years, of a total of 17.25 per cent. increased taxation, the counties touched by the canal transportation have borne 16.5 per cent. of it, and the other counties the small sum of but three-quarters of one per cent. A better canal means larger commerce and consequently increased wealth where it is handled. Hence, the improvement of the canals will continue to relieve the people of the interior from any increase in taxation, and will benefit the State at large by increasing its commerce."

If, for the sake of argument, it be presumed that only those counties which contain important terminals, reap a direct benefit from the canals, it also appears that of the State taxes for 1894, such counties (or Erie, Albany, New York, Westchester and Kings) paid $7,032,303, while all the others together paid but $3,385,888.

It should also be borne in mind that prosperous canals afford one of the largest and best markets of the State for labor and farm produce, as every boat spends from $2,000 to $3,000 annually for these commodities, a sum amounting to millions of dollars.

Viewed from any standpoint, there can be found but the one conclusion, that our canal system has been one of the most important of the many resources which have made ours the "Empire State," and maintained in our borders, New York city, "the imperial mart of the world."

But the wisdom of their conception and construction, and the details of their subsequent maintenance and operation have passed into history and the record must stand. What concerns

us more vitally now is the manner in which the waning importance and usefulness of the canals can be restored and maintained against the competing influences which threaten on every hand, for it is undeniable that the canals of to-day do not constitute the important element in our progress that they did only a few years ago. With the westward growth of population, progress and civilization, the market conditions have somewhat changed, and much of the freight which once found its only market at or near our eastern seaboard, now finds that best of all markets, the home market, while the surplus products which are still marketed most profitably in the more densely populated eastern States or foreign ports, is no longer confined to our own water route, but finds other numerous and ever increasing outlets.

Our Canadian neighbors, profiting by the example of what our canals have done for us, have not been slow in grasping the magnificent opportunity of capturing to their own profit, a goodly portion of the northwestern commerce which was once wholly ours. They have less than 50 miles of canal to maintain, to provide continuous navigation from the Great Lakes to the ocean. This route is now available for vessels of nine feet draft of water, but this is rapidly being increased to 14 feet, many of the locks designed for the latter depth being already completed.

The Canadian government still exacts tolls on all freight passing through its canals, but these have been largely reduced since 1882 when our canals were made free, and it is probably only a question of a few years before they will be wholly abandoned, in order to enable them to further compete with our canal system.

We must not be unmindful of our neighbors activity in canal improvement, for every step taken by them in this line means that they will thereby gain much that is now ours. We must outgrow the belief that the enormous northwestern freight traffic is ours by divine right, and that it must always follow the route in which it has traveled for so many years. Time and cost will always constitute the main factors in determining the

popularity of any route, and if other routes be made quicker and cheaper than ours, at least to points of export, we may confidently expect to see a goodly portion of our commerce seeking those routes. But Canadian competition is not wholly confined to their water route. The great Canadian Pacific railway system, stretching across the continent from ocean to ocean, is a rival of no mean proportions. Water routes will doubtless always have an importance vastly greater than railroads, but the influence of the latter on the problem of the distribution of the products of the great northwest is being felt to an increasing extent every year.

We can not overestimate the value nor importance of railroads to every person and every industry, and it is gratifying to know that there is room enough and work enough in this great State and nation to keep both the rail and water routes busy handling the commerce which seeks them. Each acts as a feeder and helper to the other, for it is a matter of history that the most prosperous railroads are those running parallel with important water routes.

But the railroads have progressed and improved in a manner decidedly different from the canals. The managers of the former, comprising some of the brainiest men of our age, have seen the necessity for better and quicker facilities for transportation, and have proved themselves equal to the occasion in providing them, and it is time that we begin to emulate their example, in connection with the many needed improvements on our canals, which have too long been delayed.

Surrounded as we now are by the many conveniences for quick transportation and intercourse, made possible by the recent numerous methods and applications of steam and electricity, we can hardly realize the wonderful changes that have taken place during the last 60 years in the great problem of transportation. In 1837 there were less than 100 miles of railroad in this State, and not a single through or trunk line had ever been suggested. Pieces of timber faced with strap-iron formed the rails, while the cars were little larger than wagons, and the locomotives would now be mere toys, though they had succeeded in pointing the way

toward quicker time and cheaper transportation, which were the things needed then as now. In those days the Erie canal carried practically all the freight between Buffalo and Albany. But a new era had dawned. The time for improvements was ripe, and the opportunity for gain for capital invested in railroads was very great. Every section of the country was growing rapidly, and with that growth came the natural necessity for better facilities and quicker time. Capital joined hands with genius, and skillful engineers and mechanics gradually devised the methods necessary to the desired end. The old wooden rails faced with straps of iron were relegated to the scrap heap and replaced with iron T rails, which in turn have given way to better and heavier ones of steel. The poorly kept roadbeds have been constantly improved to meet the necessities of an enormously increasing traffic; cars have been specially designed and built to accommodate the various grades of freight, steel bridges of great strength and durability have supplanted the old ones of wood, and those magnificent specimens of mechanical skill and ingenuity, the modern locomotive, now haul luxuriously appointed passenger trains from New York to Buffalo by daylight, or cover the same distance with a train load of grain equal in weight to the combined loads of five canal-boats in about one-eighth of the time still required by the boats.

But it must not be forgotten that the combined facilities of all the railroads leading from Buffalo to New York are totally inadequate to handle the business between those points, especially at rates that would compare favorably with those now charged on the canals. The year just ended has been one of great commercial inactivity, and railroads generally have suffered with other inlustries for lack of business, yet even under those circumstances they could not or would not compete with canal rates, and as a matter of fact they carried less than 50 per cent. of all the grain that was carried from Buffalo to New York for consumption or export.

But the ever-increasing tendency of railroad competition is to divert the business of the Erie canal, and, consequently, of New York city, to other points of export, and Montreal, Boston, Philadelphia, Baltimore and other ports are reaping the benefit.

New York city, with our canal system, possesses many natural advantages over any other port, but if that advantage is to be maintained, we must make the canals, which are one of its greatest feeders, adequate to handle the commerce which seeks them, cheaper, quicker, and, consequently, better than any competing route, either by rail or water.

Every day, almost, brings some new surprise in the shape of improved means or devices for saving time and expense in railroad transportation, and remind us of the wonderful age of development and progress in which we are living; but surrounded on every hand by the very air of progress and improvement, and a competition which threatens not only their continued usefulness, but their very existence. What has been done on the canals to keep them abreast the times? Certainly not much that is commensurate with the desired end, nor that tends to make them superior to competing lines, To my mind, the waning importance of the canals is not wholly due to the wonderful progress of the railroads and other rivals, but largely to the wonderful lack of progress on the canals. While it may be true that some of the lateral canals are already adequate to the demands of their commerce, with such minor improvements from time to time as would naturally follow their maintenance, it is none the less true that the Erie canal in particular, and also the Oswego and Champlain canals, are susceptible of greatly increased facilities, which will certainly be followed by increased commerce and lower rates, which, directly or indirectly, will certainly be beneficial to all our people.

I have said that many of the methods and appliances of the canals have made little or no progress, and while I shall attempt to point the way for improvement in some of them in subsequent pages of this report, I wish to recall some of them here. Is it not strange that in this age of steam and electricity, that only 55 out of the 1,243 canal boats which cleared from Buffalo during the season of 1894 were propelled by steam, and none by electricity? Aside from these few propellers, most of which are accompanied by from one to three consorts, practically the only advance made in the method of towing in the past 70 years consists in harnessing three horses so as to draw two boats,

instead of the usual two horses to each boat. The other improvements, which have been carried on with uncertain regularity and with appropriations usually too small to promptly produce fruitful results, can briefly be summarized as follows:

The Erie enlargement, completed in 1869; the irregular efforts to deepen and straighten the Champlain; the lengthening of some of the locks on the Erie and Oswego canals so as to pass two boats at a time, and the introduction at these lengthened locks of hydraulic machinery for assisting lockages. In other respects the canals of to-day are identical with those of 60 years ago, and the same methods and appliances are in vogue, while many of the structures have so deteriorated from time and neglect that they now menace not only the uninterrupted traffic of the canals, but the lives and property of our citizens at many places and in many ways. The records of the Court of Claims will show that hardly a season passes during which the State is not made to pay for accidents due to rotten bridges; for damages arising from leakage and for mending breaks in the banks, many times the cost of new structures and improvements, which would effectually put a stop to such useless drains on our treasury. Altogether too many structures of a temporary character have been erected, and the consequent cost of their maintenance and repairs is far above what it should be. I am trying to inaugurate some new methods in this line, in order to reduce these important charges to the minimum.

Just what should be done to restore our canals to their wonted usefulness and importance, and thereby retain the golden key to the commercial problem of the nation which we have so long held, is a matter not easily decided.

Many remedies and plans have been suggested, and each finds plenty of advocates and would doubtless accomplish much good, but I believe such a combination of these should be effected as will accomplish a truly comprehensive improvement, at a cost that would not be burdensome, and within the shortest possible space of time, in order to realize its benefits promptly and hold our present commerce. The first great step to be taken is to definitely settle on some general plan, broad enough

to accomplish the one object of making ours the most attractive route between the Great Lakes and the Atlantic; elastic enough to admit of prompt minor changes that may from time to time appear desirable; and so sound and well considered that in all essentials it shall suffice for many years.

The methods in vogue for so many years of spending annually a few thousand dollars toward a poorly-defined plan of general improvement, is neither wise, statesmanlike, nor economical, and such practice has not been productive of adequate results, while in the cases of many structures designed for one improvement and soon after modified for a more radical one, it has proven an absolute waste of money.

Such improvements as the lengthening of one or two locks each year, or improving a mile or two of the prism, do not accomplish any appreciable saving in the cost of transportation, for so long as only the present number of trips can be made, with the present tonnage for each trip, it must be apparent that the saving of a few hours is practically of little benefit, either to the commerce of the State or to the boatmen. Consequently, unless we abandon the present structure of the canals and substitute therefor a ship-canal of from 18 to 20 feet depth of water, thus permitting the lake vessels of modern build to pass directly to New York without breaking their cargo, it must be apparent that to accomplish any commensurate saving we must permit the largest boats that will pass the present locks, or a slight modification thereof, to carry an increased load, and carry it enough quicker and cheaper than now, that the combined saving will be equal to the gain of one or more round trips under existing conditions. I believe this can be done and at a comparatively moderate cost.

Much has been said and written concerning a ship canal to take the place of the Erie, or Oswego and Erie canals, and, to an engineer, the scheme presents many attractions, but I have yet to find any considerable body of business men, canal men or financiers that seriously believe that such a canal is an urgent necessity, or that its construction now would be expedient.

We need an improvement that can be effected promptly, and for the present, at least, to be controlled by this State.

Owing to the great amount of money involved in the construction of a ship canal, I think it safe to assume that if such a work is ever started, it will be under the charge of the Federal government. Just how long it would take under such conditions, to complete the necessary surveys and location; obtain the enormous appropriations required; increase the water supply to the extent that might be necessary, and put the whole canal in shape for operation, can better be imagined than foretold.

Furthermore, I now understand it to be the opinion of practical men in the grain business, that with the improved devices and facilities for transhipment at Buffalo and New York, their cargoes are benefited by rehandling, to an extent equal to its cost.

I understand the sentiment of the people at large, as well as the commercial bodies most deeply interested and who have made the most careful study of the problem, to be only for the greatest improvement of which the present canals (especially the Erie) are capable, without radically changing their route, structure and water supply.

On those lines, I now present my

Recommendations for Canal Improvement.

These I believe should comprise the following:

(1) The deepening of the Erie and Oswego canals to nine (9) feet, and of the Champlain to seven (7) feet, wherever and however possible without radical changes in existing structures.

(2) All single locks on the Oswego canal, and those on the Erie canal (which can not be combined and replaced by high-lifting locks), which have not already been lengthened so as to accommodate two boats at a time, and which permit of this change without undue or unwarranted cost, should be so lengthened and be also equipped with proper hydraulic machinery, not only for drawing boats in and out of locks, but also for operating lock-gates.

(3) Wherever a number of locks are combined in series or are separated by short distances, they should be combined into one quick acting, high-lifting lock, except at points where such changes are impracticable, by reason of peculiar location and surroundings. This would save much water in lockages, as well as time and expense in both operating and maintenance.

(4) Greater speed and economy in towing must be obtained by electricity.

(5) The capacity of present boats should be increased by making space now used for horses or steam engines available for cargo.

(6) The cost to the State of canal maintenance and operation can and should be reduced by the introduction of more modern methods and appliances.

As each of these improvements is a problem in itself, its solution will be attempted separately.

Deepened Canals and Increased Loads.

In 1878, Elnathan Sweet, then division engineer and afterwards State Engineer, made exhaustive experiments and calculations deduced therefrom, to determine what saving in time and increased cargo could be effected by adding one foot to the present depth of the Erie canal, by raising the top of banks and structures instead of deepening the bottom, because "deepening the bottom would add little more than half as much to the sectional area area of the waterway as by raising its surface, on account of the slopes and the necessity of leaving benches at the foot of the prism walls. The importance of this difference arises from the fact that the resistance of a boat navigating a narrow channel increases as the sectional area of the waterway diminishes."

It was determined by Mr. Sweet that "the best form of waterway should have a cross-section five and thirty-nine-one-hundredth times the immersed section of the boat, and a surface width of four and one-half times the width of the boat. The width of the canal is nearly what it should be, but it lacks depth to have the benefits of this law. One foot added to its present depth would

allow the boats now in use, without adding to their size, to carry 50 tons additional. Fifty tons added to the load of a horse boat carrying 250 tons, would add over one-fifth to its paying load. An increase of one foot draft to a propeller and its consort would allow 100 tons more load. If the boats should carry the loads they now take, they could make the trip from Buffalo to West Troy in 19 hours' less time than at present, and a boat carrying 25 tons in addition to its present load, with the same draft on horses, could make the trip in six hours' less time," while if loaded to seven feet in the deepened prism, the time for making the trip would be extended about eight hours, over that now required. Each half-foot of deeper immersion of the present boats will permit of 25 tons increase in their cargo.

One foot of water under boats at miter-sills of locks, and across aqueducts is now rulable, but at a number of these structures a greater depth is already available. I am convinced that improved gates could be placed in all existing locks which would render it possible to entirely dispense with miter-sills projecting above the floor of locks, thus adding their height, which is generally one foot, to the available depth of water, and I am further convinced that there are few, if any, aqueducts but that would permit of a corresponding deepening, without serious engineering difficulties or unwarranted cost. I believe no plan heretofore suggested has ever contemplated deepening except between structures, but I respectfully submit that it would be very desirable to have the entire canal of a uniform depth, though the following conclusions are based on deepening only between structures and assuming 15 inches deeper immersion for present or lengthened boats, thus allowing nine inches of water under boats at structures, and 21 inches at all other points. Boats now in use carry about 240 tons of grain, and as the great northwestern grain trade is the coveted prize toward the acquisition of which all improvements aim, I will take such a boat-load of grain as an example of how a saving can be effected.

One opportunity for saving lies in the improved lock-gate above mentioned. The present gates are not only unwieldy, but they occupy 10 feet of valuable space in single locks and twice that in all lengthened locks, that might be made available

for a corresponding increase, or 10 per cent. in the length of boats, thereby adding further to their paying loads.

Moreover, the present gates being built of wood, soon decay, and frequent expensive repairs are made necessary. This feature of them is also accountable for many serious accidents and delays to traffic, of which that at lock No. 45, near Ilion, early last summer, is a good example. That resulted in the loss of a good boat, together with its cargo of cement, probably worth at least $4,000.

The gate I have in mind is one built of steel, to be lifted vertically, by means of the same machinery now used to haul boats in and out of locks, or an improvement thereof, and having its guides and bearings in or near the present hollow quoins, and in a steel overhead structure, to which it would be suspended. Suitable valves for feeding could be applied to such a gate, and also be operated mechanically, or these could be entirely dispensed with and the feeding be done under the gates. One man, assisted by the boat's crew, should be able to manipulate all the parts of such a lock

A lock equipped with such gates and permitting the passage of boats 10 feet longer than at present, would require less water than now, because the additional length of boat would displace a corresponding quantity of water which is now wasted.

If by the introduction of an electrical towing device such as I shall suggest, which will take up absolutely no space on the boats, we can add further to the boat's capacity by making the space now used for horses, or engines and coal, available for cargo, we will have reached the maximum in that direction, with the assumed depth of water over structures.

And now to summarize the effects to be thus obtained:

	Tons.
The present loaded boat is	240.0
Fifteen inches deeper immersion will add to this	62.5
Making new load for present boats	302.5
Add 10 per cent. for increased length by improving gates	30.2
Add for space now used for horses or engines	17.3
Making a total possible load of	350.0

Or an increase of 110 tons or 46 per cent.

Since this increased capacity, at the same cost of transportation and with same margin of profit, is equivalent to a corresponding decrease in the rate of freight, we should expect to see the present rate of about three and one-half cents per bushel reduced to two cents, which would still leave the boatman an increased margin of profit on the season's business amounting to about $100, assuming that no additional profit is made on west-bound freight. I understand this to be the mark aimed at by several improvements that have been suggested, but which were much more radical than those I have indicated. However, it must not be forgotten that the time required to move such increased load will be greater than that now required by about nine hours between Buffalo and West Troy. Hence to realize fully the saving above indicated we must improve the method of towing and the facilities for quick lockages to a compensating extent.

I also believe this can and should be done, and a discussion of those features will be found under their proper captions in the succeeding pages hereof.

The Oswego canal affords the connecting link between the Erie canal and the growing commerce of Lake Ontario, and is a very important part of our canal system. Its depth of water and size of locks are identical with those of the Erie canal, and I believe the foregoing reasons for improving the Erie canal are almost equally applicable to the Oswego.

It is of prime importance that the most heavily loaded boats of the Erie canal should be able to pass through the Oswego canal without breaking cargo, and I recommend that the depth of water of both be maintained alike. The locks being of the same size as the Erie locks admit of the same improvement in all respects.

Champlain Canal.

On completion of the work now under contract about 28 1-2 miles of this canal will be enlarged. The greater portion of the enlargement having a uniform depth of six feet, 44-foot bottom width and 58 water surface. This leaves about 36 1-2 miles of unimproved canal, as will be seen by the accompanying profile. The towing-path bank will have a top width of 14 feet and a height of two feet above water surface at the inner angle.

The improved portions are not continuous, the work of improvement having been confined to the sections most in need of it. The six feet depth of water has been obtained by deepening the prism. From 1870 to 1874 the legislative acts providing for the enlargement were as follows:

Chapter 788, Laws of 1870, appropriating the sum of $425,000 for enlarging in such manner as to give throughout the entire length a uniform depth of seven feet of water and a width of 44 feet on the bottom and 58 feet water surface, except as in the opinion of the Canal Board may be required for business purposes, when in that case the walls may be made vertical, but retaining the same depth of water and width at water surface.

Chapter 399, Laws of 1874, appropriating the sum of $500,000 for enlarging the canal in the same manner as provided for by chapter 788, Laws of 1870.

Chapter 301, Laws of 1884, reappropriating $201,283.66, the unexpended balance, with the accumulations thereof of the sum of $500,000 appropriated by chapter 399, Laws of 1874, for bottoming out the prism of the canal and the Glens Falls feeder and raising and strengthening the banks thereof so as to produce a uniform depth of six feet throughout the entire length.

Since 1884, various appropriations have been made for improving the Champlain canal, and in each case the enlarged section has been as specified in chapter 301, Laws of 1884.

The amounts expended will be compartively valueless, unless the whole enlargement shall be completed.

It is recommended that the entire canal be enlarged so as to have a uniform depth of seven feet.

The plan of enlargement should include the straightening of the line of the present canal; sharp curves now exist which render navigation very difficult where a direct line over a nearly level surface, and no more expensive, could have been adopted.

From information at hand, it appears that the enlargement of the canal can generally be done by excavating the bottom from the junction at West Troy to the Saratoga bridge at Northumberland, and by raising the banks, from the Saratoga bridge to Whitehall.

The commercial value of the improvement depends upon the cost, increased capacity of tonnage, decreased cost of transportation and the required amount of water supply for the enlarged canal.

The cost of enlargement can be ascertained only by careful surveys and estimates.

The increased tonnage of one boat would amount to about 50 tons for each foot deepened, providing no change is made to present boats, nor structures.

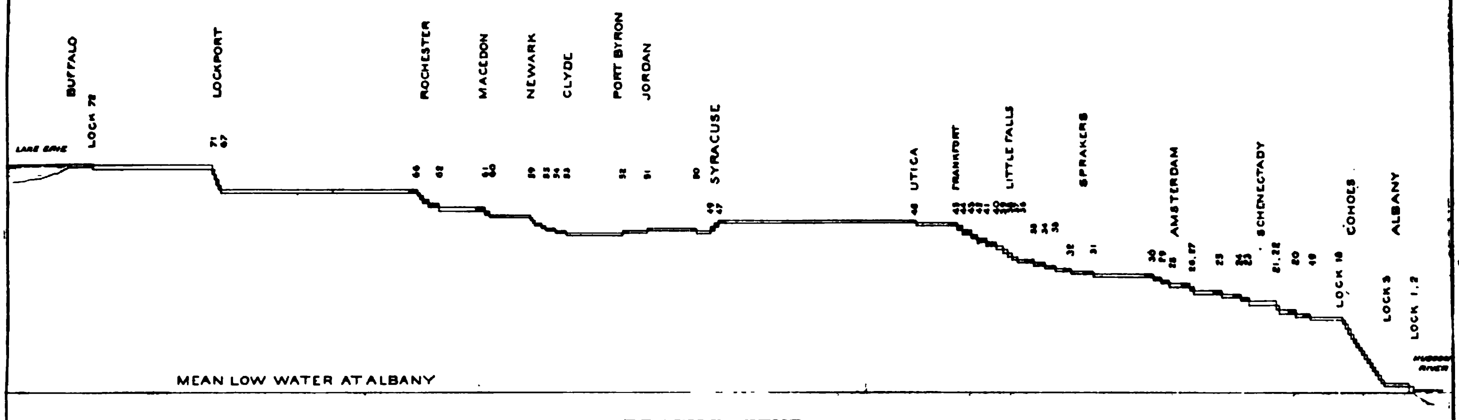
The decreased cost of transportation depending upon the, relative resistance of boats moving in the present canal and like boats moving in the enlarged canal, can readily be ascertained by a series of experiments, but in a general way the results would be as outlined in the above description of the Erie canal deepening.

The water supply required for the enlarged canal, and the sources for obtaining the same, present a problem which would require careful consideration.

It is presumed that the present Legislature will arrange for an appropriation for extensive canal improvement, in obedience to the wishes of the people as expressed at the recent election, and to be ratified by them at the next election. In the meantime, I desire to remind the Legislature that an enormous amount of both field and office work must be done by this department, before an extensive improvement can be started, and that our working force must in that case be considerably augmented. To a great extent, this office lacks the proper data for reliable estimates for any considerable improvement, and I respectfully suggest that an appropriation should be made available for the collection of such data during the coming summer, in order that we may be in position to award contracts promptly after navigation closes next fall, providing the people shall by that time have ratified such proposed appropriation for canal improvement.

Lock Lengthening.

All the Erie locks are " twin " locks, two of the same size being placed side by side. There are 72 of these twin locks, making 144 working locks, each 110 feet long. In forty cases, one of the



PROFILE OF THE

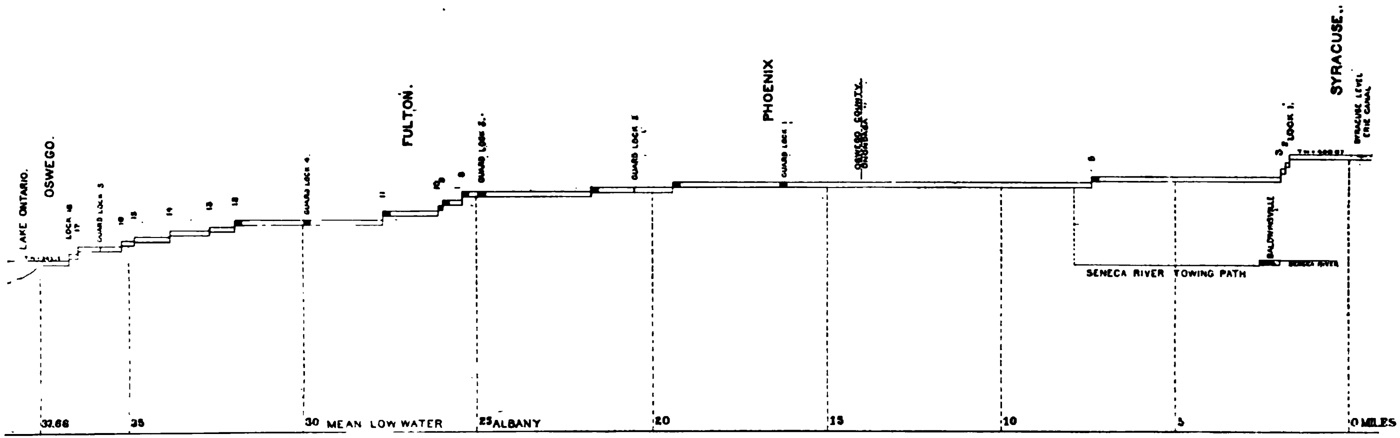
ERIE CANAL

SHOWING LENGTHENED LOCKS.

1894

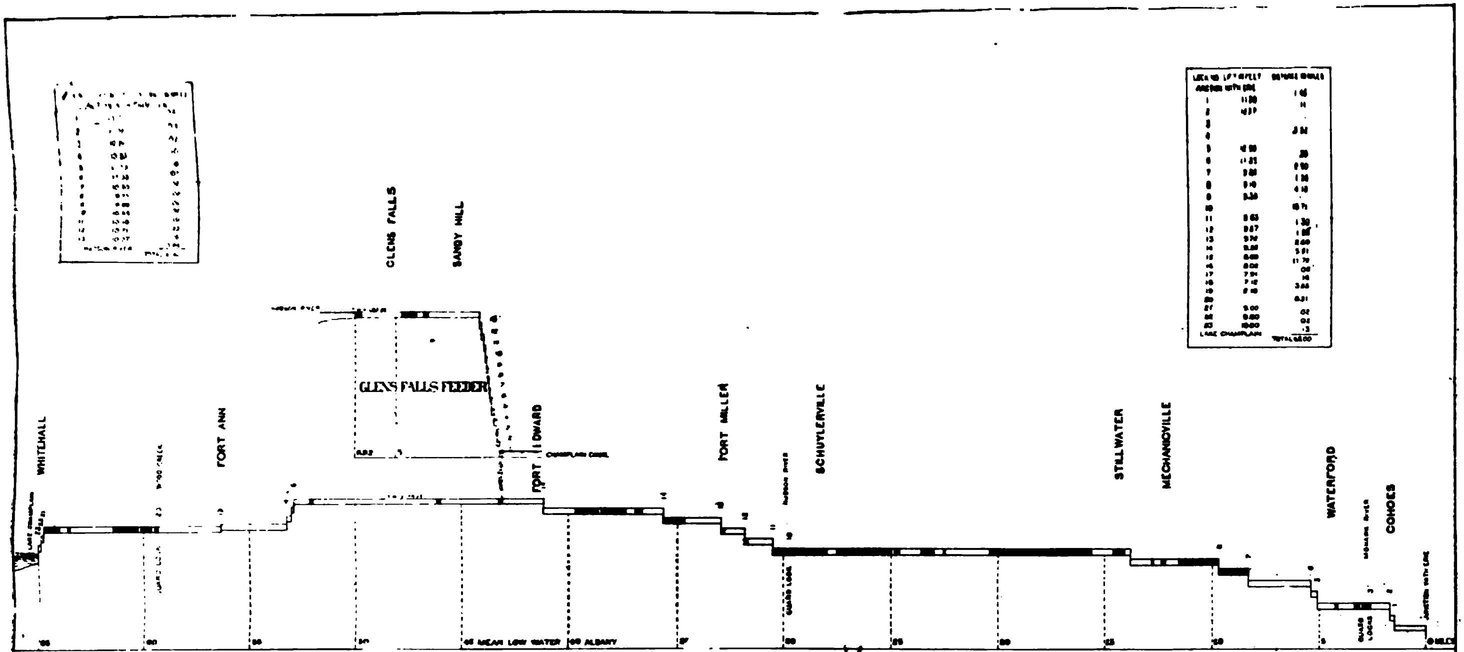
NOTE: ═ DENOTES LENGTHENED LOCKS.

PROFILE OF THE
OSWEGO CANAL
SHOWING LENGTHENED LOCKS
1894



NOTE : DENOTES LENGTHENED LOCKS

A.M.Evans



PROFILE OF THE

CHAMPLAIN CANAL

SHOWING IMPROVED SECTIONS

1894

NOTE: ▬ DENOTES IMPROVED SECTION
BOTTOM WIDTH 44 FT. DEPTH OF WATER 8 FT.

A.M.Evans

FIVE COMBINED LOCKS AT LOCKPORT.

twin locks has been lengthened to 221 feet, thus accommodating two boats at one lockage.

The above number of lengthened locks includes lock No. 20 which is now in course of construction. The profile of the Erie canal on the opposite page, shows in solid black, those locks which have been lengthened. A glance at this profile will show that of the remaining 32 single locks, 16 are in the series known as "the sixteens" between Cohoes and the junction of the Erie and Champlain canals, at West Troy; five more are combined at Lockport; three are very close together at Newark, four more are in the same condition at Little Falls, and still two more (Nos. 20 and 21), at Rexford Flats. Locks Nos. 1 and 2 complete the quota of single ones at Albany. Lock No. 1 does not admit of being lengthened without great cost, owing to its peculiar location, which necessarily have to be changed if the lock were to be lengthened. I do not think it of great importance now that either locks Nos. 1 or 2 be lengthened. The great bulk of traffic which passes these locks is in connection with the Albany lumber district, which occupies nearly all the space between them. There are, however, no extraordinary difficulties to be overcome in lengthening lock No. 2.

The next unlengthened locks are the "sixteens" above mentioned, and the profile plainly shows what a formidable obstruction they must necessarily be in the way of quick time. They are distributed over a distance of three and a quarter miles, the space between them varying from 450 to 1,500 feet. Their location is in such a tortuous and winding route, that if lengthened by the common method, it would be quite impracticable for two connected boats to pass in and out of the locks and around the intervening sharp curves. For this reason, and because of the great cost of lengthening all of them, and the practical uselessness of lengthening part but not all of them, no tangible recommendations have ever been made for their modification or improvement. All boats must now pass these locks singly, and as boats with consorts seldom carry more than one crew, they are obliged to hire an extra team and helmsman for each consort, in order to make the passage of these locks. Such

teams cost $3, and a helmsman, $2 per trip, and when this is added to the cost of lost time necessarily incident to the trip, it will be found to be quite a serious matter. It takes about four hours to make the passage of these locks under favorable conditions, but at times when trade is specially brisk it has been known to consume a day's time. It should also be borne in mind that this portion of the canal is not only expensive to the boatmen but also to the State. If it can be abandoned, as I shall suggest and advise, the State can doubtless effect an annual saving of labor and maintenance of about $25,000. Moreover, the sale of the three and a quarter miles of canal lands that could be abandoned, should afford a considerable sum which could be applied to the proposed improvement.

The plan in contemplation is briefly to abandon the three and a quarter miles of the present Erie canal, from lock No. 18 at the head of the "sixteens," to the junction with the Champlain canal at West Troy, and to use in place of this the two and one-half miles of the Champlain canal from the junction up to the guard-lock at the south end of the Cohoes dam, and, from this point, to canalize the southerly side of the Mohawk river, up to a point a short distance below the high falls and nearly opposite the present lock No. 18, where the distance from the present canal to the river is only 350 feet. This space would be covered with a steel aqueduct of suitable size, which would carry the waters of the canal to a point over the river bank, where the lifting locks would be placed. These will be built wholly of steel. The entire foundation for the aqueduct and locks is of solid rock, and the location is admirably suited to the plan, as the river bank is nearly vertical and about 100 feet high. The plan in contemplation for the locks is for two steel troughs or boxes, side by side, each large enough to accommodate two boats afloat, and each counterweighted with a weight equal to itself when loaded, and each working independently of the other. The latter feature is very desirable, because at certain seasons the great bulk of traffic is in one direction, and at such times it would be possible to lock four boats at once in the same direction. Each trough or lock would be supported at short intervals by cables or chains

attached to its sides, and extending up over suitable drums or pulleys, and down again to the counterweights.

The locks, counterweights and machinery would be supported by a trestle-like steel structure, the posts of which would afford the required facilities for guiding the locks and counterweights as they move up and down.

The end of the aqueduct on the upper level, and of the canal at the lower level, would be equipped with proper gates, to control the waters while the locks are in motion. Similar gates are placed at both ends of the lifting locks, and all are operated mechanically. The necessary devices for accomplishing this work are already in successful operation at several places, and are an assured success.

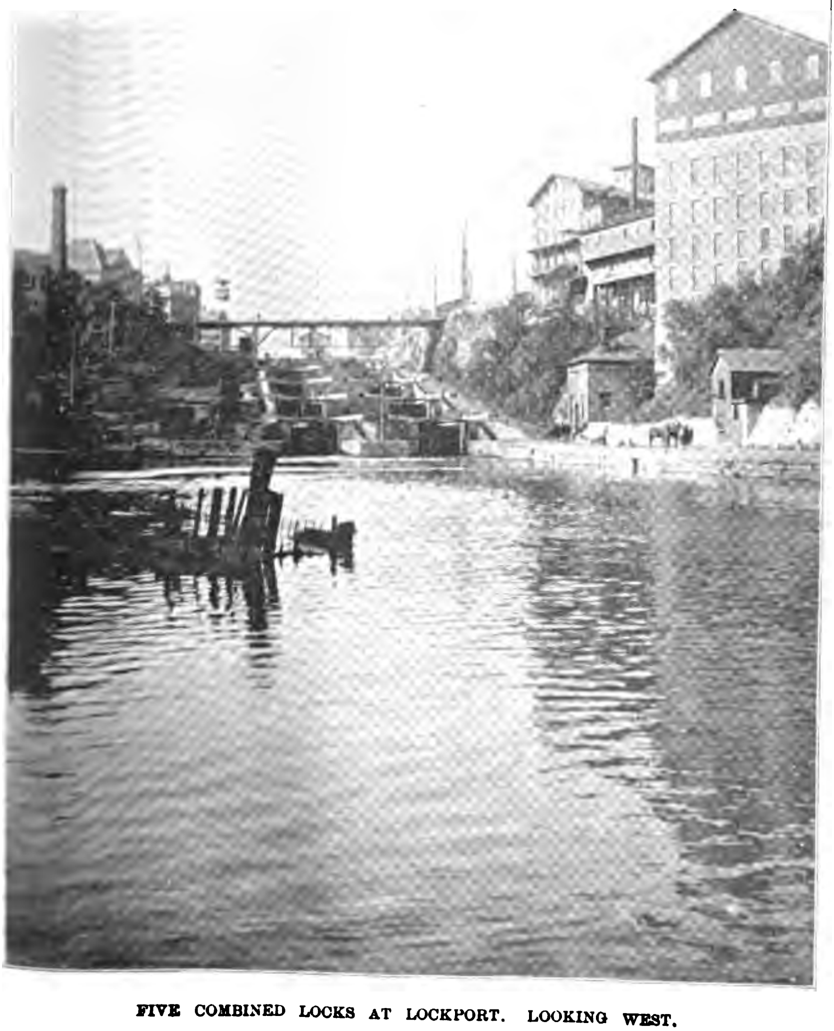
On reaching either level, the slight space between these gates is filled with water by means of valves in the gates, which are then lifted vertically to the required height, and boats can then pass in or out as the case may be. The water in the locks, however, is not wasted, but is displaced back into either level from which the boat entered the lock. The weight of the lifting locks would always be alike, whether loaded with one or two boats, or only with water, because the boats simply displace an amount of water equal to their weight.

Various methods of operating such locks are already in successful, constant, every-day use, and no particularly difficult engineering features are presented in that respect, though it is now believed that devices, simpler than any now is use, can be applied to these locks. In England, France and Belgium a number of high-lifting steel locks are in use, all of which are controlled by water pumped up into towers or presses, high enough to produce the requisite pressure, and thence introduced into single cylinders with pistons of sufficient size and strength to raise the lock. The rising piston is assisted by the additional pressure obtained from a surcharge of water in the other or descending lock, all being built in pairs, and one counterbalancing the other. The machinery, however, is somewhat complicated, and, consequently, liable to derangement, besides being quite expensive. The pistons and cylin-

ders above mentioned necessarily extend below the foundation of the lock proper, to a depth equal to the lift of the lock, since the lock is attached directly to the piston. In the cases of the French and Belgium locks, the lift is about 45 feet so that the depth of the shaft or pit to contain these cylinders is not a particularly serious matter. But at Cohoes, where the lift will be 140 feet, such a device would be very expensive and quite impracticable. However, it is not necessary, and one can be substituted that will prove equally efficient with practically no liability to derangement and frequent expensive repairs. It must be understood that the plans for these structures are by no means complete and these remarks should only be treated as general suggestions of the principal features as they are now contemplated, and will doubtless be planned. Numerous lifting devices suggest themselves, but the one which seems to promise the most fruitful results, is simply a surcharge of water, sufficient to overcome by its weight the friction in the movable parts, and overbalance the counterweights, when the lock is to descend, and to be decreased to a corresponding extent less than the counterweights, when the lock is required to rise. Such surcharge of water, probably not exceeding three inches in depth, can be added at the upper level, simply by stopping the lifting lock slightly below that level and opening the gates, when the water would flow in, at the same time helping to carry boats in with it. Being thus overloaded, the lock will descend by its own weight, slowly or quickly, as may be desired, by simply regulating the amount of surcharge, and being governed and controlled, probably by air-brakes applied at each drum or pulley over which the cables pass, or as may hereafter seem more desirable.

The descent being thus under perfect control, the lock would be brought to rest without jarring by the aid of proper pneumatic or hydraulic buffers. These would also be placed at the upper levels and would regulate the positions of the locks when at rest to a nicety.

At the lower level, the lock would come to rest so that its water surface would be above that of the canal, by just



FIVE COMBINED LOCKS AT LOCKPORT. LOOKING WEST.

Fig. 1.

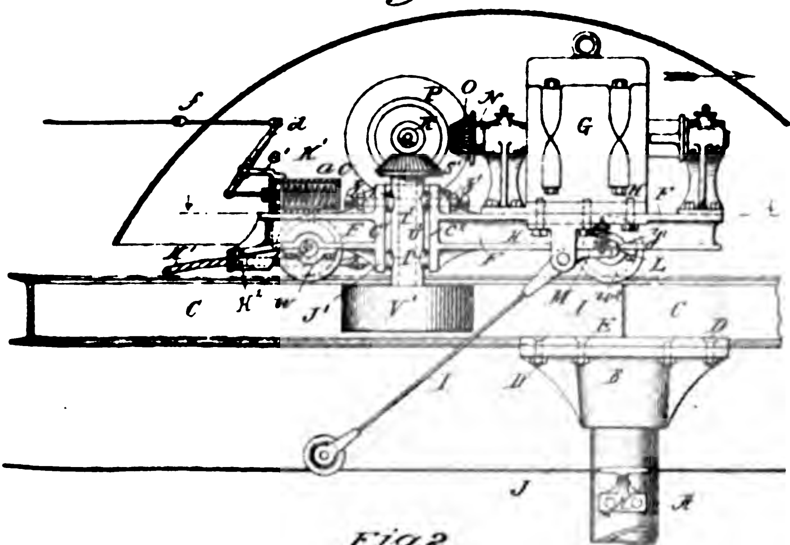
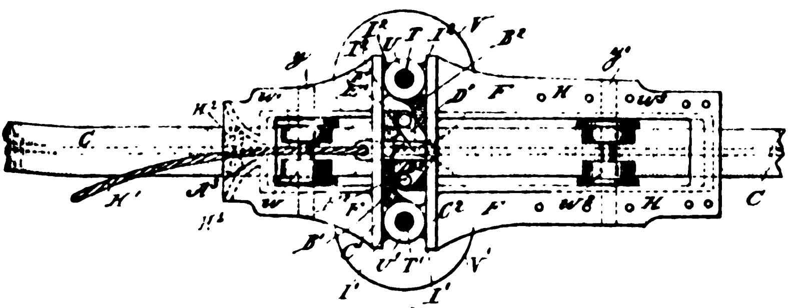


Fig. 2



WITNESSES:

Edward C. Rowland.

George L. Dillon

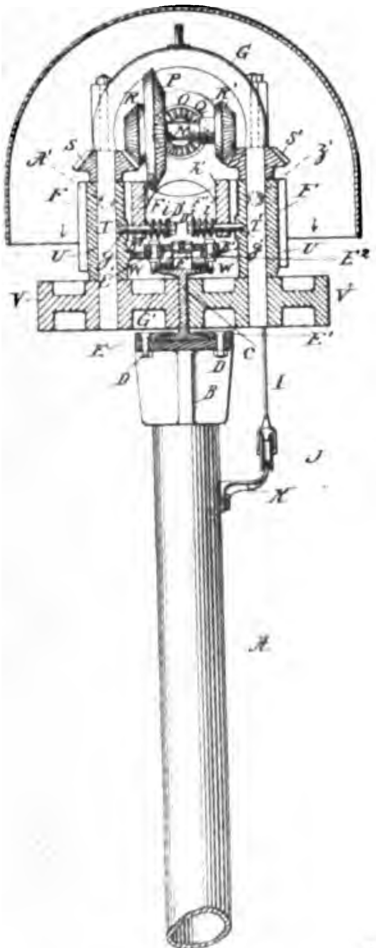
INVENTOR

Thomas P. Milligan

BY Phillips Abbott.

ATTORNEY

Fig. 3.



WITNESSES:

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ATTORNEY

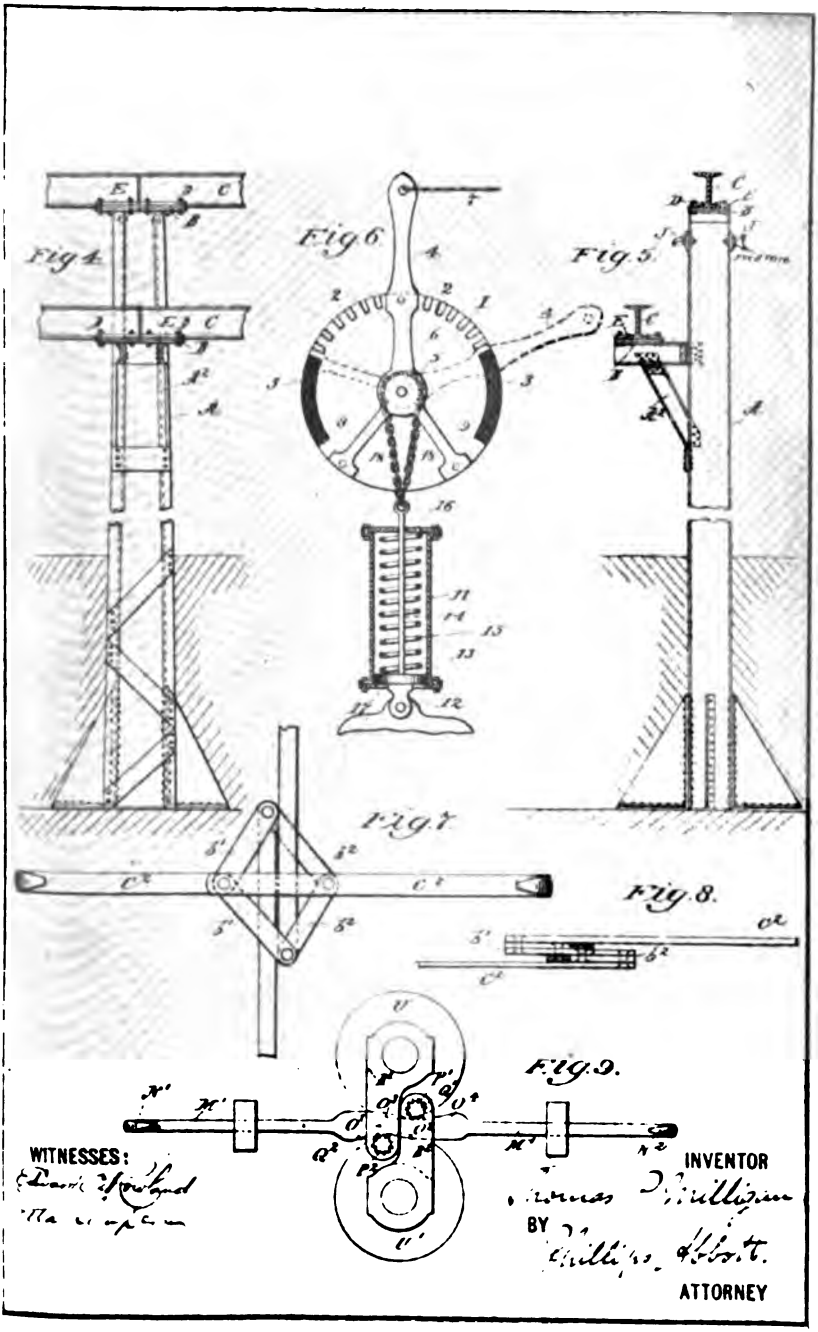


Fig. 4.
Fig. 6.
Fig. 5.
Fig. 7.
Fig. 8.
Fig. 9.
WITNESSES:
INVENTOR
BY
ATTORNEY

twice the space it was below the upper level when receiving its surchage. Then opening the gates, this double surcharge, if it may be so called, would escape into the lower level, again helping to carry the boat out of the lock which would still contain water enough to admit and float an incoming boat.

Having thus lost twice the load with which it was surcharged for its descent, it will be correspondingly lighter than its counterweights which would, therefore, pull it back to the upper level ready to repeat the operation.

I had expected to be able to present to the Legislature the plans of such a lock, in connection with this report, but that has been found impossible. They are, however, being made, and, as they give promise of such fruitful results, I trust the Legislature may see fit to provide the necessary funds for further research and the compensation of such expert engineers as it will be found necessary to employ to develop the most satisfactory plans.

The five combined locks at Lockport offer an exceptionally fine opportunity of combination into one steel lock similar to those above described, and it is expected that plans may be ready for this point in time for the consideration of the Legislature during the present session.

The next locks which have not been lengthened are Nos. 21 and 22, and considerable difficulty would be encountered in lengthening these in the ordinary way because of the close proximity of the upper Mohawk aqueduct, at the upper end of lock No. 21, and also because of the sharp curve which turns almost a right angle between the present locks. I believe that here, also it would be found advisable to combine these locks into one high-lifting lock, similar to that above described, and I suggest that any law that may be passed authorizing the lengthening of these locks be so drawn as to leave it optional with this department whether they shall be lengthened after the manner heretofore in vogue or whether they shall be combined into such a high-lifting lock as I have suggested.

The next unlengthened locks are at Little Falls and here, also, serious difficulties exist in the way of lengthening or combining by any plan.

For the present, at least, I do not recommend that anything except ordinary repairs be done to the locks at Little Falls or Newark because, owing to their peculiar location and surroundings, it will be found excessively costly to either lengthen or combine them.

I have said that boats carrying 350 tons in the manner proposed would require about nine hours more time between Buffalo and West Troy than is now required, and that in order to insure the same number of round trips as at present this time must be compensated for by improved lock and towing facilities. By improving the "sixteens," locks Nos. 21 and 22, and the five at Lockport, as above suggested, it will be possible to compensate for over one-half of this time beyond question, while in the case of west bound boats which can not be "swelled" in or out of the locks by water, as it is now done on the east bound trips, the saving of time over present methods will probably be equal to the additional time required as above for the heavier boats. Moreover, it must not be forgotten that deepened canals will require more water, and the introduction of these lifting locks, which would only use a slight amount of water, presents a means of economizing in the water supply.

Electricity on the Canals.

The many wonderful achievements of recent years in the development of electricity as a motive power, inspire the hope that it may soon be made applicable to the propulsion of canal boats, at a cost that would render its use practicable and profitable to all concerned. The excessive weight and expense of the best storage battery which science has, as yet, devised, and which would be sufficiently powerful to meet the needs of this service, seem to exclude such an appliance from serious consideration at this time.

The next alternative is a motor fed from a trolley-wire, which shall either be placed on the boats so as to drive the present form of propeller or else be carried on its own wheels along a track built for the purpose, and arranged to tow the boats after the same manner now in vogue with animals.

The whole question is purely an economic one; efficiency, desirability and cost being the points to be considered.

Each of the present methods of towing has its advantages and disadvantages.

Animals for power have the advantage of cheapness of first cost, but owing to their lack of both power and speed they may be said to be epensive because they do not accomplish what should be accomplished by each trip.

Moreover they are both useless and expensive while the boats are on the river between Troy and New York, or about five days of the time required for each round trip.

Steam propellers have the advantages of both power and speed; they can haul three consorts; they are as independent on the river as on the canal, and they can pass from point to point in New York and Buffalo harbors to discharge or take on cargoes under their own steam, thus avoiding the necessity for the expensive assistance of tugs. Their disadvantages consist mainly of the first cost, or installation of machinery, which is so great as to be practically prohibitive to hundreds of the boatmen; the excessive weight of machinery and coal which should be transformed into paying load, and which is equal to eight inches of immersion of present boats; the disproportionate cost of generating steam in such small quantities, and the fact that the action of the propeller wheels tends to immerse or draw the boats deeper into the water than would be the case by pulling instead of pushing them along.

Any method of electrical trolley propulsion must necessarily lose the advantages of steam propellers on the rivers and in harbors, hence some compensating advantages over steam must be had before electricity will take its place. Such advantages might consist of greater efficiency while on the canals; cheapness, both as to use and installation; desirability and economy of space and weight. Motors placed on the boats and made to operate the common form of screw propellers will not accomplish any appreciable saving of either weight or space over a steam engine and boiler and in many respects would be decidedly inferior thereto.

Such a method would require two trolley wires, for boats bound in opposite directions, and the boats would be helpless when not nearly under these wires. Moreover, the cost of installing such a device in the boats would be practically prohibitive to the

majority of the boatmen, the cost being nearly that of steam, while lacking its many advantages above mentioned.

A trolley motor, running on its own tracks, attached to tow lines as now used; controlled by a line extending back to the helmsman, and requiring no space on the boats, seems to promise several advantages over present method, at least with the great majority of boats, among which is the possibility of renting such power when it was needed, thus requiring no outlay for installation. Such trolley lines could be built on either side of the canal or preferably, as a double track (two rails) on the outside of the towpath, and high enough above it that animals could pass underneath the lines running to these motors, when towing by present methods. Such a device would require little change in present methods, as the motors could be considered as "electric horses."

Several devices have already been planned or suggested, as a substitute for either animals, steam or the common form of electric motors above alluded to, and we may confidently expect to find many more, when a determined effort on the part of the State to solve the problem shall be apparent.

Especially along the Erie canal there are many opportunities to develop electrical energy from water power that is now either wasted or not fully utilized, and these points should be carefully examined, and reliable estimates prepared showing their capacities and cost of development. To accomplish this most successfully, experts must be employed who can give undivided attention and intelligent study to the subject.

I earnestly recommend that a suitable appropriation be made to cover further researches and experiments in the line of electrical or other mechanical means of propelling canal boats.

Through the courtesy of Mr. T. P. Milligan, I am able to present herewith some illustrations of his electrical device for towing canal boats, together with his views as to its capabilities. It can hardly be claimed that this device in its present shape would solve the whole problem of electrical propulsion, but I believe the general methods which are intended to be applied are started in the right direction, because no space on the boats is required for machinery; because present methods of operating

with tow-lines would require little or no change; because the power need not necessarily cost the boatmen anything when not in use, and because it would not interfere with any method of towing now in vogue.

The Milligan Electric System for Canal Boat Propulsion.

Before considering this system, the circumstances under which it, or any similar one, must be introduced, should be considered; that is to say, any device for the purpose must be adapted to existing conditions.

Any device designed to supplant the old-time mode of towing by horses or mules must be one which shall move the boats by towing them, and do this without requiring any alteration in the boats or in bridges, and without obstructing the towpath. It must be effective and so simple that an unskilled person can operate it; it must be absolutely free from danger, durable and preferably inexpensive in erection. The motor must be under complete control from the boat, i. e., it must be started, stopped or reversed from the boat, as circumstances may require. It should be able to move the boats as fast as the depth of the water will permit, to handle them in the locks, and it must not interfere with or obstruct the bridges that now span the canal; and, as before stated, the towpaths must be left free from obstruction and open to the employment of towing by horse or mule power to all who prefer so to do; this being a statutory right.

The foregoing requirements have all been considered by Mr. Milligan, and it is believed that his system comes as near as possible to supplying the requirements above stated, and it appears to solve the problem of easy and rapid transit by canal.

Synopsis of the System.

The Milligan system, briefly stated, is as follows: A line of posts (see cut No. 1) are planted on the back edge of the towpath. These posts are made in the most substantial manner, are set upon concrete or rubble foundations, and support two continuous rails: one on top of the posts, which may be the west-bound track, and the other on brackets, two or three feet below the top of the

posts, constituting the east-bound track. These posts are, say, 14 feet high, so that the motor trolley wire or conductor and all parts of the structure are sufficiently elevated to secure freedom from injury and to prevent danger to animal or human life.

An electric motor of, say, 20-horse power, adapted to run on a single rail, and so constructed that it can not be dislodged therefrom, is the motive power. This motor is of an entirely novel construction, and, though small and light in weight, grips the web of the rail with a power which automatically adjusts itself to the strain on the towline. If a heavy load is to be started, the grip is instantly increased and when the starting strain is removed, the grip lessens, thus there is complete automatic adjustment. The power operating the motor is an electric current supplied from power-houses erected at suitable distances, or from other sources, as may be desired.

The current is conveyed by wires similar to the ordinary trolley wires, which are supported on insulated brackets projecting from the main posts (see cut 2). The current is taken from the trolley wire to the motor by a brush, trolley wheel, or otherwise, and is turned on and off by simple, efficient devices operated from the boat. The motor operates equally well in either direction.

Advantages of the Milligan System.

Among others, this system seems to possess the following advantages:

1. Low cost.

The posts and I-beams, which form the tracks, are common commercial articles, which may be bought in any quantity at recognized low cost.

2. No grading is necessary.

3. No weight upon the tracks, excepting the motors, which are relatively light.

4. Perfect control of the motor from the boat.

5. Fast boats can change motors with slow boats.

6. The heavier the load the greater the traction, and this is automatically adjusted.

7. Unusual simplicity in the parts, and they may be all made large and heavy, insuring durability.

8. The State can own the motors and track and rent them at so much a mile.

9. The current can be generated at places where water-power is available, thus reducing expense.

10. No right of way has to be bought. The State already owns the towpaths.

11. The same posts can be used, if desired, to support insulated cables for supplying current to towns for power and lighting, and the State can rent the privilege of their use to local companies.

Cost.

A careful estimate by a responsible firm, which stands ready to do the work, is as follows:

1. Motors, in lots of 25, each $350.

(Of course, the first motor will cost more.)

2. The rest of the structure complete, per mile $14,500.

Terms.

Mr. Milligan stands ready to grant to the State of New York the right to employ his system on all the canals of the State, on a fair and equitable royalty, or he will entertain a proposition to sell the right to the State of New York, or to sell his inventions outright.

Detailed Statement of the Invention.

The construction and method of operation of the Milligan system, set forth in detail, is as follows:

Figure 1 illustrates a sidewise elevation of the invention, the hood being sectioned longitudinally.

Figure 2 illustrates a plan view, the hood, the motor, gearing, etc., being removed the better to show the construction and operation of the toggle-arm mechanism, which automatically adjusts the traction to the resistance.

Figure 3 illustrates a transverse vertical section on the line I of Figure 1.

Figures 4 and 5 illustrate a modification showing two tracks on the same line of posts.

Figure 6 illustrates a switch mechanism whereby the motor may be reversed and made to run backwardly.

Figures 7 and 8 illustrate a modified construction of the toggle devices whereby the motor may be run in either direction.

Figure 9 illustrates a modified draw-bar.

Referring first to figures 1, 2 and 3: A illustrates one of a line of posts; they support the track-rail and are of such length above ground as preferred. B are castings fastened to the tops of the posts; C are the rails which constitute the track; they are, as shown, ordinary shallow trusses of wrought-iron "I" beams and are fastened upon the top of the castings B, by bolts D and anchor-plates E; no fish-plates are required. F is the frame or truck of the motor. It is preferably a casting. G is the electric motor proper. It may be of any preferred form and will not be particularly illustrated or described, since they are now well known in various forms. The motor is bolted to the frame F by bolts H, or in any other suitable manner. I is the trolley device, which engages with the conductors J in any preferred manner. The conductors are shown in figures 1 and 3 as supported upon brackets K on the posts A and a spring L (see fig. I), between the heel of the trolley pole hub M and the frame of the motor keeps the trolley in contact with the trolley wire in aid of gravity. The spring will not always be required. N is the main shaft of the motor, upon its rear end is a bevelled pinion O, which gears into a reducing gear P, set on a counter shaft Q, upon which are two bevelled pinions R and R^1, which mesh respectively into two other bevelled gears S, S^1, which are keyed to the upper ends of two vertical shafts or axles T, T^1, which are journaled respectively in sleeve bearings U, U^1; and on the lower ends of the shafts T, T^1, respectively are keyed the main driving wheels V, V^1. These drivers are of such diameter and width on their faces as will adapt them to rest against the vertical web of the I beams C. W, W^1, W^2 and W^3 are four wheels, arranged in pairs, running on axles Y and Y^1, which are journaled on the main frame. These wheels are flanged on their outer edges, and they run upon the top member of the I beam C, their flanges embracing the edges of that member, thus the motor and its frame are sustained by and move upon the track rail and the flanges on the wheels W. W^1, W^2 and W^3 plus the bearing of the drivers on the web of the rail prevent the motor

from leaving or being pulled away from the track. Instead of the wheel W, W^1, W^2 and W^3 four in number and arranged in pairs there may be two of them only, one in front and one in the rear if preferred.

The sleeve bearings U, U^1 are pivoted to the main frame, on pins or centers, Z, Z^1 respectively, and at the lower part of each sleeve, there is attached a horizontally extending plate B^1, B^2 (see fig. 2); these plates cross each other and are guided by and slide on transverse plates C^1, C^2 of the main frame. D^1, D^2 are a pair of toggle levers. They are pivoted respectively to the horizontal sliding plates B^1, B^2 at E^1, E^2 and are pivoted to each other and to the draw-bar F^1 at G^1. The draw-bar passes through and is supported by a slot made in the rear plate C^1 of the main frame, and the rope or cable H^1, which extends away to the canal-boat, is fastened to it, and passes through an opening A^3, made in the rearmost part of the frame. There should preferably be a short section of wire cable, say a foot or two in length, attached to the draw-bar and projecting rearwardly from the frame a sufficient distance so that all wear against the sides of the opening A^3 will come upon the wire cable, and place anti-friction rollers H^2 in the frame to relieve the cable of wear. I also prefer to have a hook on the end of the section of cable over which a ring on the end of the tow-line may be slipped when lifted by the boatman on the end of a suitable pole or crotch provided for the purpose. The sliding plates, B^1, B^2, are thickened or filled-out where they respectively join the sleeve bearings U, U^1, and are formed into bearing surfaces I^1, I^2 resembling hubs, which give a good, broad support against the frame at J^1, J^2 (see fig. 1 and 2) to resist the strain of starting the boat or other load. g. g^1 are two bolts or rods, which are respectively threaded or otherwise fastened to the sleeve bearings U. U^1; they pass through plates h, h^1, which form part of the main frame, and i, i^1 are springs which surround the bolts and abut against their heads at one end and the said plates at their opposite ends. The functions of these devices is to permanently pull the sleeves bearing U and U^1 inwardly so that the driving wheels shall always be in contact with the web of the rail, so that traction and consequent movement of the motor will always be secured, whether there is a resistance on the draft cable H^1 or not.

K^1 (see fig. I) is a switch of any preferred construction whereby the current can be turned on or off from the motor. In the example shown in this figure the switch comprises a cylinder, a, in which a piston, b, mounted on a rod moves. The piston engages with suitable contact surfaces on the inside of the cylinder, which may be of any desired construction. They are not illustrated in detail, because many different forms are now well known. A spring, c, normally thrusts the piston to the left and a lever, d, which is pivoted at e to the cylinder or other suitable part, and a pull cord, f, which extends rearwardly to the deck of the boat gives movement to the piston in the opposite direction. When there is no pull on the cord, then the spring, c, throws the piston to the extreme left-hand end of the cylinder, onto an insulated plate or part, and then the motor is cut out Of course, suitable return circuit wires (not shown) are provided, because it would be unsafe, ordinarily, to go to ground through the posts. K is a metallic hood which covers and protects the whole apparatus.

The operation is obvious. When desiring to start his boat, the boatman pulls the cord, f, and the switch throws the current into the motor, which immediately starts. The degree of pull on the cord will determine the amount of current and speed of the motor. As soon as the strain comes on the cable H^1, the toggle levers, acting to the right and left, cause the driving-wheels to hug hard on the web of the track rail, thus increasing the traction which they ordinarily have by reason of the springs, i, i^1. The boatman, after the cable has become taut and the boat is under its usual headway, pulls the cord, f, as taut as necessary to maintain the proper current for the speed desired, and he can then, if he prefers, make the cord fast. When wishing to stop, he slacks up on the cord, f, and the spring, c, then immediately returns the switch (piston b) to the insulated part or cut-out, and then all current ceases.

Under the plan shown in figures 1, 2 and 3, one track only is shown; the one going in the opposite direction should be erected on the opposite side of the canal. Sometimes this can not be conveniently done — consequently at figures 4 and 5 a construction is shown in which a second track, as supported on brackets, A^2, which are bolted to the sides of the posts so that

the track is lower than the track on the ends of the posts as shown. The construction and operation of all the parts are the same as already described — and the vertical position of one track relative to the other is such that the towline from the upper motor will pass over the lower motor and its towline, and consequently boats going in opposite direction can pass each other. This figure shows the trolley wire or conductor arranged above the upper motor; this construction may be employed when only one track is used, if preferred.

In Figure 6 is shown a peculiarly constructed switch, whereby the current may be reversed and the motor run backwardly. In it 1 represents a switch provided with resistance contact plates 2, and insulated contact pieces 3, a lever 4, is pivoted at 5, and there is a hub 6, surrounding the pivot. This lever has one long arm, as shown, to which the pull cord, 7, is attached, and two diverging arms, 8 and 9, respectively, which have contact surfaces on their ends; 11 is a cylinder, pivoted at 12 to any suitable support, upon which it may rock; 13 is the piston within the cylinder, and the piston rod, 14, is surrounded with a spiral spring, 15. Sixteen is a small air vent at the upper end, through which the air can be slowly ejected. The bottom of the cylinder is as open as may be, as shown at 17. Eighteen is a chain, the two ends of which are fastened to the upper end of the piston-rod, and the bite of which is fastened by a staple or otherwise to the top of the hub, 6, so that when the lever is moved in either direction, one side or end of the chain will be drawn upon, and the other slackened, and the piston consequently elevated, during which a slight rocking motion will be given to the cylinder, 11.

The operation of this device is as follows: The boatman pulls upon the cord, throwing in more or less of the current, as he desires. When he wishes to reverse his motor, he pulls hard upon the cord, thereby rocking the lever so far as that the long arm thereof moves upon the right-hand insulating contact surface, whereas, the left-hand shorter arm, 8, comes in contact with the circuit contracts, 2; the parts are shown in dotted lines as in transit, and the wiring of the device is such that when this takes place, the current is reversed and the motor goes backwardly. The two halves or sides of the switch are counterparts

of each other, so that the motor can run in either direction, and be reversed in either direction at will, and the two chains, or, rather, the two ends of the same chain, and the pivoting of the cylinder are provided so that the motor may be run and reversed in either direction. It will be seen that the spring, 15, the bottom of the cylinder being practically open, and thus allowing free exit of the air, will instantly return the current controlling lever to its normal position, thus cutting out all current the moment the pull on the cord, 7, is released; but, on the other hand, when starting the boat or other vehicle, the full current can not be thrown on instantly, which might strain, if not rupture, some of the parts, because the vent hole, 16, at the top of the cylinder, is made so small that the air can not be ejected excepting very slowly; thus the pull by the boatman is controlled, and however ignorant or unfamiliar he may be with the apparatus, he can not injure it or break any part of the apparatus.

Figures 7 and 8 show a construction of the toggles whereby the motor may run in either direction. In it the toggles are arranged in two pairs, b^2 and b^3, the two pairs being presented in different directions and each of them has its own appropriate draw-bar, c^2. It will be seen that by this construction the motor may be run in either direction, and the tow line will be made part of one or the other of the draw-bars, depending on the direction in which the motor is going. Of course, one pair of the toggles only are operative at any one time, the other pair moving idly under the power of the operative pair.

In figure 8 I show a form of draw, which is well adapted to use in both directions, and although not so powerful as the toggle-lever mechanism, will be desirable under many circumstances and for many uses. In it some of the parts are the same as shown in the other drawings and as above described, i. e., U, U^1 are the sleeve-bearings for the driving wheel-shafts; B^1, B^2 are the equivalents for the horizontally-extending plates, B^1, B^2 of figure 2. The other devices constitute the modification that is to say, M^1, is a longitudinally extending rod having hooks N^1, N^2 at its respective ends, which project beyond the respective ends of the motor to which the tow-line is attached. Centrally in this rod there are bearing surfaces O1, O2, O3, O^4, which,

depending on the direction in which the rod is moved, impinge and crowd laterally upon sleeves or anti-friction rollers, P^1, P^2, set on pins, Q^1, Q^2, in the ends of the horizontally sliding plates, B^1, B^2, whereby the sleeves N and N^1, are drawn inwardly and the driving-wheels crowded against the web of the I-beams, as already explained.

The details of construction may be modified without departing from the essentials of the invention.

Mr. Milligan also thinks that a cable embodying insulated conductors within its structure, and connected with a suitable switchboard erected on the boat, and there controlled by the ordinary switch crank or other suitable device, may be used instead of the devices on the motor which have been fully explained, and that it may in actual practice be preferred to the other.

THOMAS P. MILLIGAN.

By Phillips Abbott,
His Attorney, 206 *Broadway*, *New York City.*

Reduced Expenses of Canal Operation and Maintenance.

The various improvements suggested for the canals from time to time, all seem to aim toward a reduction of expenses to the boatmen and consequently reduced rates of freight. The State is vitally interested in the accomplishment of both these results, but, on the other hand, means should and could be devised to effect a corresponding saving to the State of operating expenses as well as those for maintenance. The possibilities in the latter direction depend largely on the judicious use of better and more numerous dredges, pile-drivers and other machinery required for the repairs made by the State, which are now carried on at the seasons of the year during which such work is most expensive, and practically without the aid of machinery such as is now used by most contractors and railroad companies and which is capable of largely reducing the cost of such work. Much of the work of maintaining or deepening the present levels and raising the embankments should be done during the summer months, assisted by such modern machinery as may be best suited or might be designed for this especial work. Moreover,

every structure hereafter to be built should be of the most permanent possible construction, to the end that the cost of maintenance and renewals shall be reduced to the minimum. Any temporary or impermanent structure on which the probable annual outlay for repairs and eventual renewal exceed a fair rate on the larger sum required to construct a permanent structure is a poor investment for the aside from the matter of added security incident to better structures. I desire to call especial attention to the illustrations accompanying this report, showing the character of some of the structures of recent design and also of some of thost in urgent need of repairs.

The operating expenses of the canals are probably as low as is consistent with efficient management under present conditions, but these conditions can be modified so as to effect a great annual saving. I refer particularly to the Erie canal. On this there are 72 twin-locks, each requiring the services of four lock-tenders, two each per day and night duty. By replacing the locks at Cohoes and Lockport and combining locks 21 and 22 into high-lifting locks, such as I have described, three locks can be made to do the work of 23, with no greater cost of handling the high lifts than is now required for each common lock. Thus, it would appear that, aside from numerous other advantages, they would permit of saving the cost of operating 20 locks which would amount to over $25,000 annually.

By substituting such lifting gates, as I have described, for those now in use on the remaining 49 Erie locks, I believe it would also be possible to reduce the force required to operate these locks fully one-half, thereby saving $30,000 more each year. I submit that these sums would pay for considerable new machinery and appliances.

Improvement of Hoffman Island Quarantine Station.

Chapter 270 of the Laws of 1888, created a board of commissioners consisting of the mayor of the city of New York, the mayor of the city of Brooklyn, the State Engineer and Surveyor, the quarantine commissioners and health officer of the port of New York to act as members of such commission without compensation, in making, supervising and directing needed purchases for, and repairs of and improvements at the quarantine establishment of the port of New York.

The following sums have been appropriated by the Legislature since September 30, 1893:

For care, maintenance, repairs, extension, etc., of the quarantine establishment	$3,000
By chapter 358, Laws of 1894:	
For care, maintenance and repairs	$25,000
For mattresses and bedsteads on Huffman Island	3,000
Repairs to buildings and other damages caused by storm in 1893	2,000
Fresh water pipe line for Hoffman and Swinburne Islands	8,000
By chapter 486, Laws of 1894:	
For the enlargment of Hoffman island for quarantine purposes	160,000
By chapter 768, Laws of 1894:	
For extension of dock at health officers' station	5,000

Plans, estimates and specifications were prepared for laying a fresh water pipe line from Staten Island to Hoffman and Swinburne islands, the work was advertised and proposals received, but could not be contracted for and carried out owing to the fact that the amount appropriated ($8,000) was insufficient, being barely enough to carry the pipe line from Staten Island to Hoffman Island.

To complete the work, as contemplated by the legislative act, at the least $16,000 will be needed, and I would respectfully recommend that an additional sum of $8,000 be appropriated for this purpose in order that the improvement may be made without delay and furnish a much needed protection from fire.

Plans, estimates and specifications were prepared for the enlargement of Hoffman Island. The estimated cost of the improvement contemplated to receive the buildings was $260,000. The amount appropriated, $160,000, was insufficient to complete the proposed enlargement, and the plans were revised so as to complete and partially complete the balance as far as the appropriation would admit. The accompanying map shows the proposed enlargement as per revised plans.

The work was advertised and proposals received in August. The following are the names of the bidders and the amounts of their bids:

Collin McLean	$131,956 50
F. & A. Walsh	132,689 50
Boker Contracting Co. (John A. Boker)	146,734 00
Spearin & Preston	154,522 50
P. Sanford Ross	123,523 50

The contract was awarded to P. Sanford Ross and executed September 4, 1894. The work will soon be commenced and will be difficult, owing to the exposed situation of the island and severity of the storms which are liable to occur in this locality.

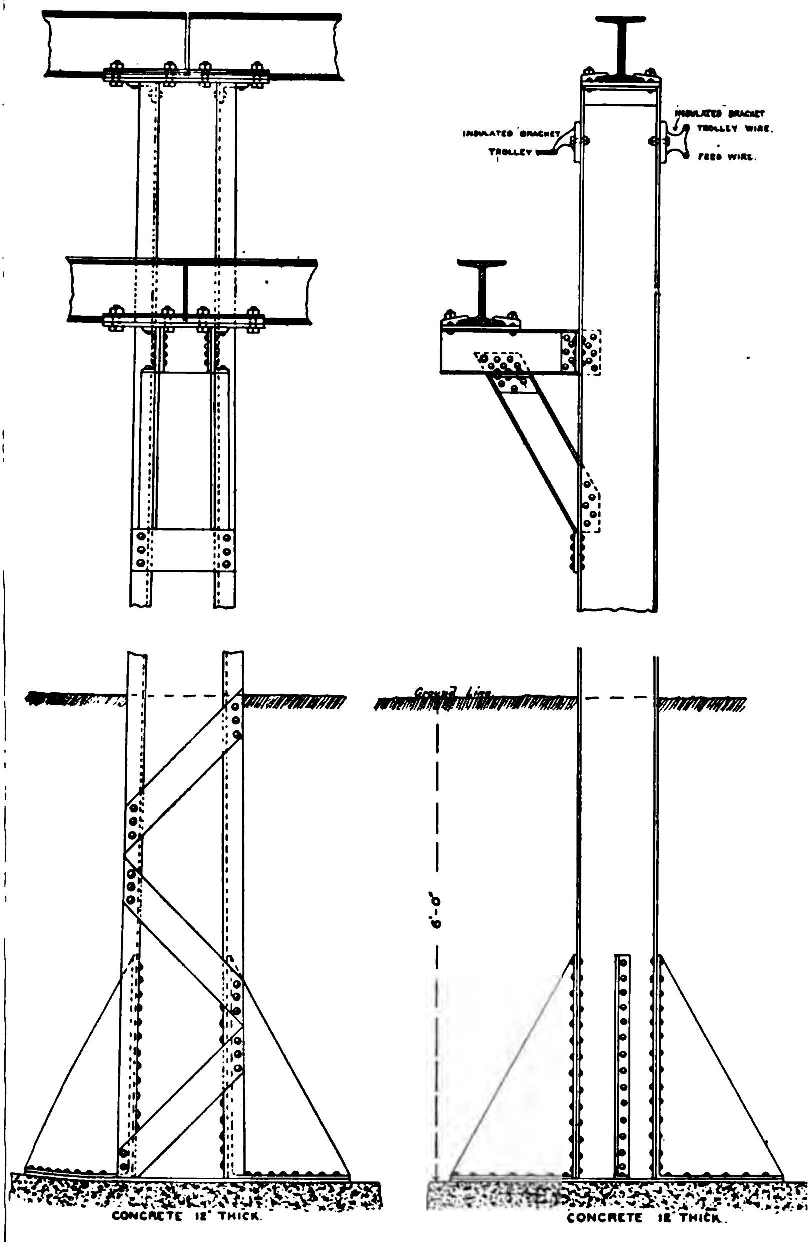
By the provisions of chapter 486 of the Laws of 1894, the sum of $50,000 of the amount appropriated was available at once and the balance, $110,000, shall be payable on the 1st day of June, 1895.

I respectfully recommend that the sum of $100,000, the balance needed to complete the enlargement of Hoffman Island, be appropriated at an early date, in order that the work may be prosecuted without interruption, thereby saving money to the State and providing the much-needed and properly-located space required for the detention of quarantine persons and property.

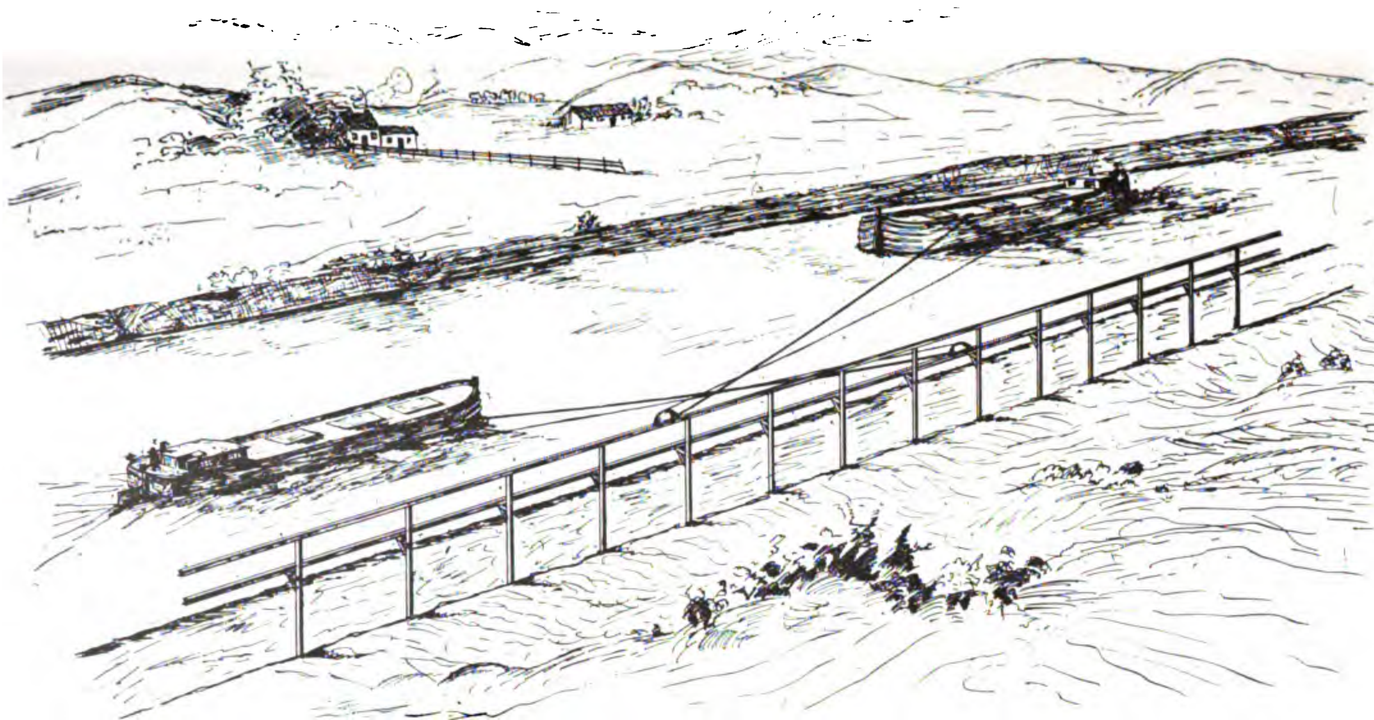
The completion of the enlargement will render it possible to strictly isolate the detained passengers in groups.

The use of Fire Island, as a detention ground by the State, has caused much opposition from the citizens of Long Island and several petitions have been presented to the Land Board asking that the property be sold on the ground that it is not suitable for a quarantine station, that the State's ownership serves to seriously damage property values in the adjacent towns and to be detrimental to the business interests of the south side of Suffolk county.

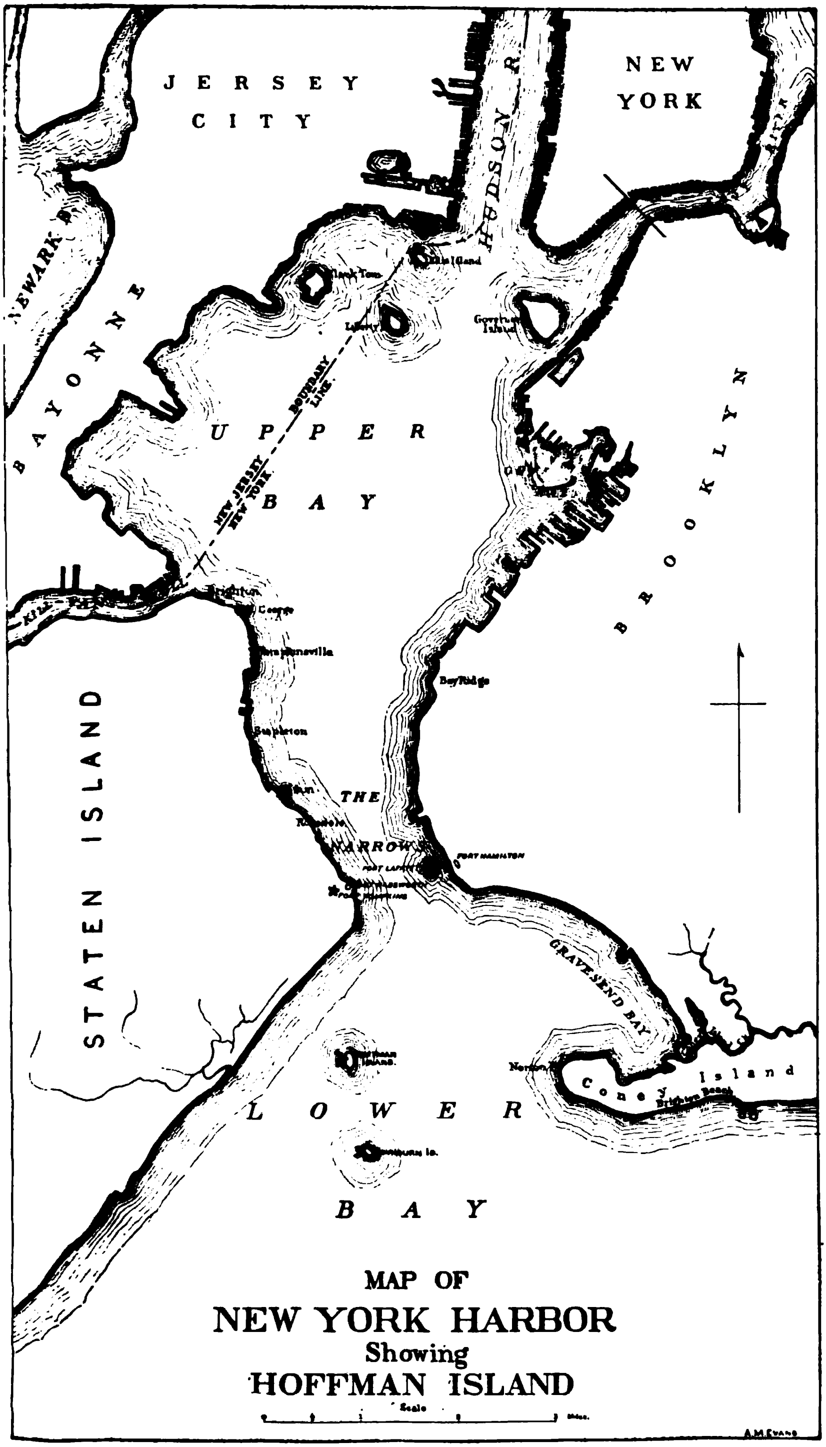
The Land Board referred these applications to the State Engineer for an investigation and report to said board as to whether the property could be sold for an appreciable sum and whether any other property more suitable and accessible for quarantine purposes can be obtained for a reasonable sum.



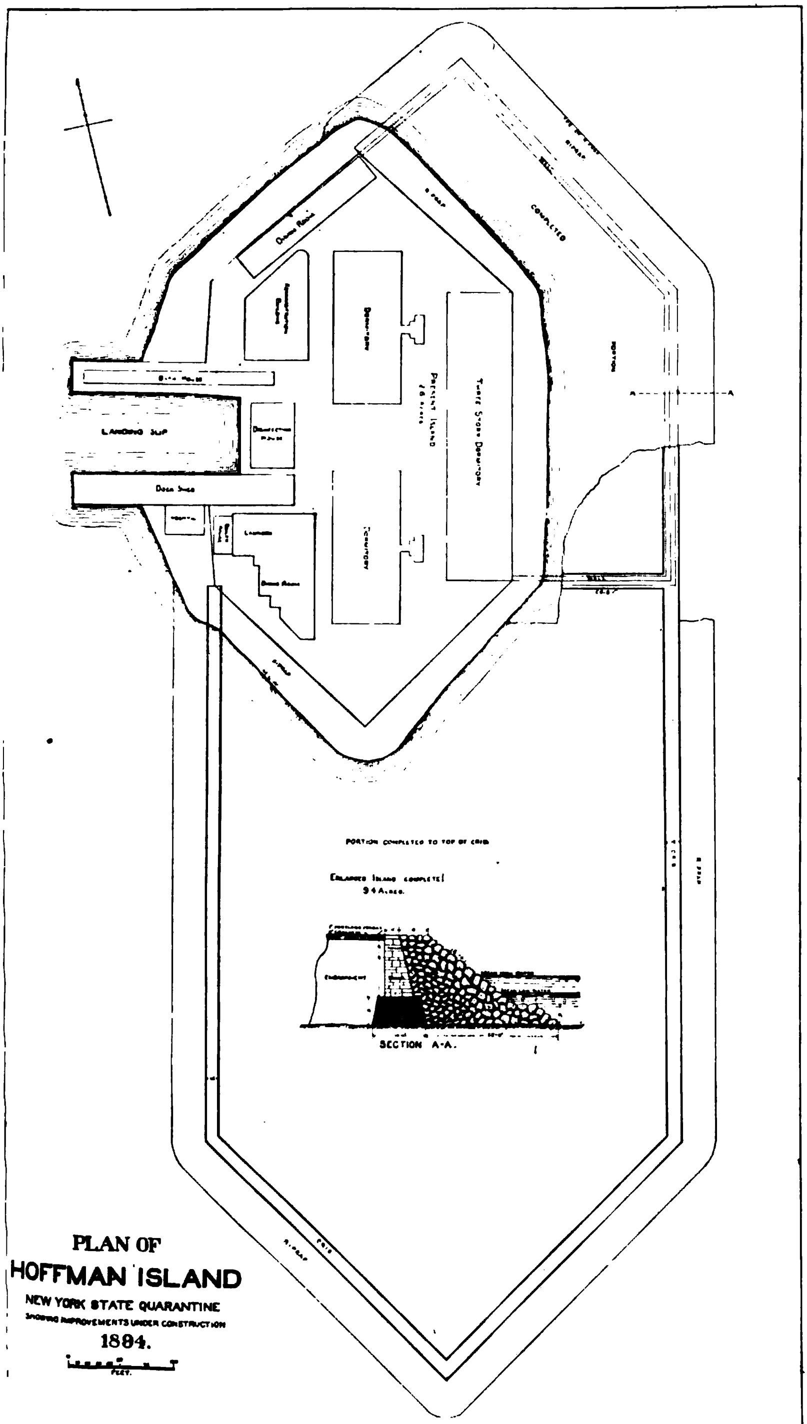
THE MILLIGAN ELECTRIC TOWING SYSTEM. DETAILS OF TRACK CONSTRUCTION.



MILLIGANS SYSTEM of ELECTRICAL TOWING



MAP OF
NEW YORK HARBOR
Showing
HOFFMAN ISLAND


PLAN OF
HOFFMAN ISLAND
NEW YORK STATE QUARANTINE
SHOWING IMPROVEMENTS UNDER CONSTRUCTION
1894.
FEET.
LANDING SLIP
Dock Shed
Bath House
Dining Room
Dormitory
Three Story Dormitory
Present Island
COMPLETED
PORTION
RIPRAP
WALL
CRIB
PORTION COMPLETED TO TOP OF CRIB
SECTION A-A.

I am of the opinion that Fire Island should not be abandoned as a quarantine station and sold until the enlargement of Hoffman Island is completed which will afford a quarantine station suitable for the proper care of detained passengers of all classes.

Detailed reports of the work done and expenditures made from the balance of the appropriations made since September 30, 1893, will be found in the report of the commission, created under chapter 270, Laws of 1888, to the Legislature.

State Lands.

The State Engineer and Surveyor, by a provision of the Constitution of the State, is a member of the Board of Land Commissioners; and to him is referred by that board all the applications for grants of lands under water; that the maps and descriptions may be examined and reports made as to whether or not the making of the grants would interfere with navigation or be a detriment to the interests of the State. It frequently happens that remonstrances, for various reasons, are presented against granting such applications. In which cases much additional labor is involved; in hearings given to the interested parties, in determining the questions at issue and afterward in making a personal examination of the lands applied for. During the last year, 40 such applications for lands under water, situated in 12 counties of the State, have been received and considered. Thirty of the parcels applied for were for purposes of beneficial enjoyment, and 10 were for purposes of commerce.

The State Engineer, by direction of the Commissioners of the Land Office, has, during the past year, sold 48 parcels of lands, for which the sum of $4,175.04 has been received.

The determination of disputed county and town boundary lines, answering many questions pertaining to colonial and early State surveys, and furnishing data in connection therewith, are sources of much correspondence and consideration.

There has been paid to the State Treasurer the sum of $50.10 which has been received for fees during the year by this department.

Office Repairs and Records.

Chapter 358 of the Laws of 1894 appropriated $2,200 for repairs to and rearranging the records of the offices of this department, and much good has been accomplished with this fund. On

assuming charge of this department, I found the offices in anything but presentable condition. Walls, furniture and carpets have been thoroughly renovated and renewed, so as no longer to be eyesores to both occupants and visitors.

Owing to the importance of this portion of the work, which, by reason of long-continued neglect, had become an absolute necessity, the work of rearranging and indexing many of the records has had to be deferred till further funds are made available, though much work in this line has already been done and is now in progress.

Many of the oldest and most valuable records have become almost worn out from constant use. These should be copied, so as to preserve the originals as far as possible. In a general way it may truly be said that the system of indexing heretofore in vogue for the numerous maps, plans, field notes, bills of material, original monthly and final estimates, reports, etc., have not kept pace with the growing business of the department, and it is now well-nigh impossible to find much of the information which the office should afford to both citizens and officials. Practically every record of the office should be examined, reclassified and properly indexed, on some general plan, that may be found most advantageous.

The usefulness of the department depends largely on the accessibility of these records, both to the engineers and clerks of the department, and to the public that uses the information therein contained.

I trust a suitable appropriation may promptly be made available for continuing this important work.

Another matter in this connection seems to merit your attention.

It is a somewhat startling fact that this department does not possess a map of any of the State canals, with the lands and structures thereof, as they exist to-day. Thousands of changes have been made in alignment, size, location of structures, and lands required, and while there exists a record of nearly all of these matters, the data is on separate and scattered sheets, and is practically useless, because it is so inaccessible.

Sooner or later the time will come when it will be a matter of great importance that this data be collected, so as to be of some

practical use, and I urge that it be done now, while the services of many of the older employes of this department, who are familiar with these changes, are still available.

To accomplish this, and much other work that should be done, will require an increase in the available funds for this department, which are now barely sufficient to maintain the present force, which is, on this account, necessarily kept at the lowest point. For this reason, every member of the present force is fully engaged on the work actually under way, and little or no time is found available for the study of new designs, or for the revision of maps and other office records. This work can not be successfully done by piecemeal, but should have the undivided attention of a skillful engineer and draftsman, classed in the civil service, so as to be selected by the State Engineer.

An appropriation for this purpose should promptly be made available, in order that this department may attain its greatest efficiency and usefulness to all concerned.

ALBANY, *December* 31, 1894.

HON. C. W. ADAMS:

Dear Sir.—I most respectfully submit the following report of cement tests for the fiscal year ending September 30, 1894. The figures represent the average of the number of lots as taken from the records of cement tests in office of cement testing department, New York State canals:

	Samples.
No. 1 slag cement; brand, Puzzolon, Brunswick, Germany,	20
No. 2 slag cement; brand, Puzzolon, Brunswick, Germany,	20
No. 3 slag cement; brand, Puzzolon, Brunswick, Germany,	20
Wayland, Portland	345
Iron Clad, Portland	840
Jas. Behan, brand for Superintendent of Public Works...	240
Special sand tests for State Engineer	6
	1,491
Number of samples tested for cement used on work.....	1,562
Making a total of	3,053

Representing 30,530 barrels.

PROPORTIONS USED IN MIXING, CEMENT 1, SAND 1.

BRAND.	Number of lots.	Number of barrels.	Seven days.	Twenty-eight days.
Bangs & Gaynor	81	4,636	94	196
Ramsey's Howe's Cave	17	2,490	75	164
Hoffman Rosendale	7	810	84	162
Buffalo Cement Co	3	300	114	204
Hudson River Rosendale	1	42	70	164
F. O. Norton's Rosendale	1	149	77	195
Akron, Ohio, Rosendale	1	110	108	224
Dunlop's Hydraulic	1	30	138	234
Newman's Akron	4	370	107	218
Star Brand Akron	6	530	73	188
Bridge Brand Portland	1	125	88	177
Saylor's Portland	12	1,100	290	383
Wayland Portland	11	1,100	389	479
Toltec American Portland	9	1,225	174	280
Empire Portland	20	2,230	170	252
Brown's	4	380	53	114
Total	179	15,627	......	....

State Topographic Survey.

Since 1893 the State of New York has been engaged in co-operating with the United States Geological Survey in the making of a topographic map of its territory. This work was inaugurated in pursuance of chapter 287 of the Laws of 1893, which authorized the State Engineer and Surveyor to co-operate with the Director of the United States Geological Survey in making a topographic survey and map of the State. This act appropriated the sum of $24,000 for the co-operative survey, and made a further appropriation of $6,000 for locating and marking upon the ground in advance of the topographic survey the lines between the several towns and counties in the State. In accordance with the above law, my predecessor, Mr. Martin Schenck, signed in April, 1893, the following agreement with Major J. W. Powell, Director of the United State Geological Survey.

Agreement Between the State Engineer of New York and the Director of the United States Geological Survey for the Construction of a Topographic Map of the State of New York.

(1) The preparation of the map shall be placed under the supervision of the director of the United States Geological Survey, who shall determine the methods of survey and map construction.

(2) The order in which, in point of priority, different parts of the State shall be surveyed shall be agreed upon in detail by the State Engineer and the Director of the United States Geological Survey.

(3) The work shall be based upon the triangulation of the United States Coast and Geodetic Survey, the United States Lake Survey and the New York State Survey, and wherever the triangulation is deficient it shall be supplemented by the United States Geological Survey.

(4) The survey shall be executed in a manner sufficiently elaborate to prepare a map upon a scale of 1.62500 exhibiting the hydrography, hypsography and public culture, and including all town and county boundary lines as established and marked by the State Engineer at the time of its completion in form similar to the sheets already completed in this State. The preliminary field maps shall be on such a scale as the Director of the United States Geological Survey may select to secure accuracy in the construction of the final map.

(5) The hypsography shall be shown by contour lines with vertical intervals of 20 feet.

(6) The heights of important points shall be determined and furnished to the State Engineer.

(7) The outlines of wooded areas shall be represented upon proofs of the engraved map to be furnished the State Engineer.

(8) For convenience the Geological Survey shall, during the progress of the field work, pay the salaries of the persons employed therein, while the traveling, subsistence, and field expenses shall be paid for the same time by the State. For office work on map the salaries shall be divided between the two agreeing parties in such a way as to equalize all expenses, provided that the total cost to the State of New York of the

field and office work for the current year shall not be more than twenty-four thousand dollars ($24,000), and provided that the United States Geological Survey shall expend an equal amount.

(9) During the progress of the work, free access to the field sheets and records of the topographers and draughtsmen shall be afforded the State Engineer for examination and criticism; and should the said State Engineer of New York deem that the work is not being executed in a satisfactory manner, then the said State Engineer may, on formal notice, terminate the agreement.

(10) The resulting map shall fully recognize the co-operation of the State of New York.

(11) When the work is completed, the State Engineer shall be furnished by the United States Geological Survey with photographic copies of manuscript sheets; and when the engraving is completed and at all times thereafter when desired, the said State Engineer shall be furnished by the said survey with copper plates of the sheets of the map for use in transferring for printing editions of said maps.

(Signed) J. W. POWELL.
MARTIN SCHENCK.

The work of marking town and county boundary lines was completed in the fall of 1893, and the sum of $6,000 appropriated therefor was entirely expended in the prosecution of that work, and the final report of progress under this appropriation was submitted to you in the annual report of the State Engineer, dated September 15, 1893. I shall, therefore, report here only upon the work of topographic map making prosecuted under the above agreement.

I append hereto the report of Hon. C. D. Walcott, director of the United States Geological Survey, giving description and cost of the work done during the past year on the topographic survey, also accompanying papers containing lists of spirit level elevations and primary triangulation positions established in the prosecution of this work. I also wish to call your attention to the constructive and concise statement appended hereto and sub-

mitted by Mr. H. M. Wilson, geographer in charge of the field work of the topographic survey, a description of the purposes and uses of the topographic map of the character being made by this survey. I desire to call your especial attention to this report with its accompanying maps and papers, and to ask of you such careful consideration of this subject as, in my opinion, its importance demands. I earnestly hope that you will recognize the wisdom and economy of continuing the policy of State and national co-operation in this work about on the lines laid down in the statute of 1893, and carried into effect through the above agreement, and to that end I heartily urge that you adopt the necessary legislation requisite to secure this result.

This policy received the hearty indorsement of the last three State Engineers, but before committing myself to its indorsement I gave the matter most careful and serious study, only to arrive at the conclusion that this is the most speedy and economical way of procuring for the people of the State as accurate and complete a map of its territory as its wealth and the importance of its engineering undertakings demand. Numerous arguments have been urged upon me that instead of advocating a work estimated to cost but $10 per square mile, it would be better to make a survey with greater degree of scientific and mathematical accuracy and of such character that its results should be permanently recorded upon the ground. Upon examination of the methods in vogue in this survey and the resulting maps I concluded that the accuracy of the field work was all that could be desired for the production of maps upon the scale of one mile to one inch, and that this scale is the best for the use of the general public. The method employed by the United States Geological Survey has stood the test of 10 years of time and has been used in the survey of hundreds of thousands of square miles, and I can not see how any other method could be devised which would not be largely experimental and might not increase the cost of the work from $10 per square mile to between $30 and $50 per square mile.

The maps as now published are printed on sheets approximately 13 by 17 inches and contain each from 215 to 225 square miles according to latitude. As the area of the State is 50,000

square miles, the publication of the atlas of its area will require between 250 and 260 separate sheets, making allowance for border sheets containing only portions of the State.

As shown by the accompanying reports of the director of the United States Geological Survey, there remained unexpended at the beginning of my administration, about $4,000 of the $24,000 appropriated for the making of the topographic map. Of this sum $2,300 were expended in paying the salaries of draftsmen engaged on office work, so that at the inauguration of the field season of 1894 there remained unexpended scarcely $1,700. There have been mapped during this season 600 square miles at a cost of $3,475, which is at the rate of $5.79 per square mile. The cost of plotting this work during the ensuing winter will be about $1,975, which will bring the total cost of surveying and drawing the maps for 600 square miles up to $5,450, which is at the rate of $9.09 per square mile. The cost of this to the State, which paid $1,700 of the above sum, will be at the rate of $2.83 per square mile.

The total appropriation of $24,000 made by the Legislature of 1893, has now been expended, while the United States Geological Survey will in the same time and in the co-operative prosecution of the same work have made an expenditure of $34,142. It will thus been seen that the latter organization has more than fulfilled its agreement to expend an amount equal to that appropriated by the State. Prior to the season of 1893, there were mapped by the United States Geological Survey 4,159 square miles, and during the past two seasons of co-operation there were mapped $5,850 square miles, making a total of 10,009 square miles, or one-fifth of its area, mapped to date within the borders of the State, and leaving about 40,000 square miles of its area, or four-fifths, yet unmapped. The director of the United States Geological Survey claimed in the beginning that the cost of this work would average $10 per square mile, and that if appropriations were continued by the State at the rate of $25,000 per annum, 10 years would see the completion of this great work. It must be a source of gratification to him as it is of surprise to me to note the degree of system to which the work of his organization has been reduced to enable him to estimate so accurately.

The rate of mapping, as shown in the season of 1893, was a little over 5,000 square miles on an expenditure of approximately $50,000 by the co-operating parties. During the years 1893-1894, work was prosecuted in various sections of the State; in the most populous cities, the most difficult and inaccessible portions of the Adirondack wilderness, and the open plains country about Buffalo. In this time, 5,850 square miles were mapped at a total cost of $58,150, or at the rate of nearly $10 per square mile. It, therefore, appears beyond doubt that on the basis of an annual appropriation of $25,000 by the State the entire work can be completed within eight years.

It is true that without State aid this work will go forward, but it is also a fact that if State aid is withdrawn the United States Geological Survey, will, as it did during the past season, devote only that percentage of its total apropriation to the work which this State is entitled to out of the appropriation for the entire United States. I believe that under such circumstances there is little likelihood of the completion of the mapping of this State within the next fifty years. The suggestion is often made, "Is it not possible for the State itself to make these maps, creating its own organization for this purpose?" Beyond question this is possible, but it is equally certain that it is neither as economic nor as expeditious or sure a means of obtaining the desired result. It would take several years to create such an organization as that possessed by the national government. A peculiar class of skill is required of the topographers who make these maps, and such kind of skill can not be bought in open market, but must be developed, a process which would be difficult of accomplishment unless permanence of employment were assured, and such guarantee the State can not make. Even if the State could make these maps at the same cost as the government does, namely, at $10 per square mile, that sum would be double what the State paid under the present agreement by which it furnishes but half the cost of making the co-operative survey. Finally the maps being made, the cost to the State of engraving and publishing them would add nearly as much as the original cost of mapping them, and this is done by the government at no cost to the State. It is very evident, therefore, that the opportunity of co-operating with the government in the

completion of this work at this time is one which should not be neglected.

As before stated, chapter 287 of the Laws of 1893, appropriates $6,000 for another branch of this work, that of locating and marking county and town boundary lines. The lack of positive information relative to these boundary lines is surprising and leads to tedious and expensive litigation, involving the ownership of private lands and the rights of corporations and municipalities. Many of the counties and towns in this State are absolutely ignorant of their boundary lines, and less than 3 per cent. of the town lines are marked by permanent monuments. The location of most of these lines can only be determined by the testimony of the surveyors or citizens, now most of them old in years, and by such temporary marks as stakes and blazed trees. This testimony is rapidly disappearing as the older inhabitants die and the trees decay, and with each year the work of recovering these lines becomes more difficult and expensive. If this work is to be prosecuted at all, it would seem wise to have it done contemporaneously with the topographic survey, as the topographers, in the course of the making of their maps, discover most of the existing lines. By this means the State will benefit by the work done by the topographers, while the latter will be able to properly place these lines on their maps as the State locates the more obscure ones.

The sum which was appropriated under the provisions of the Law of 1893 was scarcely sufficient to determine and locate the lines over the areas being mapped by the topographic parties. A much larger sum will be required in order that the lines may be properly fixed and permanently marked. To this end further laws should be enacted conferring upon the State Engineer and Surveyor authority to settle boundary disputes arising between town officers. I respectfully call your attention to the law proposed and recommended by my predecessor in his last annual report, dated September 30, 1893, pages 59 and 60.

I earnestly recommend that appropriations for continuing the co-operative topographic survey be made both in the supply and general appropriation bills for 1895. It is desirable that this work be pushed to a speedy completion while the Geological Survey is still able to co-operate with the State and before its

energies and funds are directed into other channels by their agreeing to co-operate with other States. The general government appropriates but a limited sum for this work, and if much is devoted to co-operative work in other States, we may lose the opportunity of ourselves co-operating with them. Such field work must be prosecuted during the summer months, and, in order that this work may be continued during the field season of 1895, the appropriation for this purpose should be made immediately available, and to that end should be contained in the supply bill. In order that this appropriation need not again be introduced in the supply bill, but may be continued hereafter in the regular appropriation bill, it should enter that bill for this year, when it will become available at the end of the field season of 1896. In this way only can we provide against a lapse of this important work and assure its continuance to completion.

Primary Triangulation in New York.

Method of work.

A comparatively small amount of triangulation by the United States Geological Survey has as yet been necessary in addition to that of other organizations. The State is about half covered by triangulation, including the work of the United States Lake Survey, along the Great Lakes and St. Lawrence river; that of the United States Coast and Geodetic Survey along the Hudson river, Lake Champlain, and the Mohawk Valley; and that of the New York State Survey in the central and southern portions of the State. The work in certain areas was supplemented by the United States Geological Survey during 1892 and 1893. In June, 1892, a small belt was extended northeastward through Washington county, starting from stations Greenwich, Rafinesque, of the United States Coast and Geodetic Survey. Nine stations, controlling four atlas sheets, were occupied. Stations were located on bare hills, though they were not always the highest in the locality, to avoid erection of expensive scaffolds, or heavy damages for destruction of timber.

Later in the season of 1892 a system of quadrilaterals was started across the Catskill region from Powell-Merino, stations

of the United States Coast and Geodetic Survey in the Hudson Valley near Coxsackie. Seven stations, controlling three atlas sheets, were located. Old observatories were found on many of the wooded mountain summits and were sighted as signals and occupied with the theodolite.

During 1893 work was extended across Clinton county from the line Lyon-Dannemora, of the United States Coast and Geodetic Survey. The northern border of the State is very difficult to triangulate, there being no well-defined points after leaving the high rocky peaks of the Adirondack region, the ridges being flat and heavily wooded. Eight stations within three atlas sheets were located.

The work in Oswego and Jefferson counties was based upon stations of the United States Lake Survey, Sandy Creek-Mannsville being used as a base in Oswego county and Cooper-Gleason in Jefferson county. Eighteen stations were occupied in this portion of the State, furnishing control for five atlas sheets.

A few stations in addition to those of the United States Lake Survey were located in Chautauqua and Erie counties. The line Silver Creek-Dunkirk light-house was used as a base from which the positions of five stations were determined.

In October, 1893, four stations were located in Ulster county, southwest of Kingston; these were based upon Terry, Prospect, and Lloyd, stations of the United States Coast and Geodetic Survey on the banks of the Hudson near Rondout.

All of the work of the United States Geological Survey in New York has been done by S. S. Gannett, assisted by B. C. Washington, Jr. A Fauth eight-inch theodolite has been used, angles having been read, in most cases, by the method of directions. No least square figure adjustment has been made.

Descriptions and Positions of Stations.

DEERING.

Station located on north end of high ridge, in town of Arkwright, Chautauqua county, N. Y., about one-eighth of a mile south of Sheridan line, 175 yards west of main north and south road. Louis Deering owner of property.

Permanent mark: Copper bolt in boulder, stamped U. S. G. S., 456, N. Y.

[Latitude, 42° 25′ 49″.50. Longitude, 79° 14′ 19″.03].

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Dunkirk, L. H	126	32	17.5	306	27	36.1	4.07358
Brooks Chimney	130	51	26.9	310	47	59.1	3.96816
Pierce	265	48	43.8	85	47	06.4	3.88766
Dean	209	02	04.8	29	05	29.7	4.15428
Silver Creek	186	44	32.3	6	45	07.2	4.00268

SHEFLIN.

Two miles south southeast of Angola Depot, in town of Evans, Erie county, N. Y., about 75 yards north of Brant line or road: One-fourth of a mile east of north and south road. Station in pasture on highest ground owned by Jacob Sheflin.

Permanent mark: Stone monument 4 feet long, copper bolt stamped U. S. G. S., 459, N. Y.

[Latitude, 42° 36′ 38″.41. Longitude, 79° 00′ 30″.72.]

TO STATION.	Azimuth.			Back Azimuth			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Pierce	31	45	15.2	211	39	18.2	4.36058
Dean	57	47	53.1	237	41	58.0	4.15089
Richmond	283	07	13.0	103	12	33.2	4.04439

RICHMOND.

Not occupied, situated in Erie county, N. Y. Station on land owned by Nathaniel Richmond, in North Collins, one and one-half miles west of Langford, just north of main east and west road; just north of and 75 yards distant from house of Charles Crook, 10 feet northeast of old well.

Permanent mark: Stone monument, copper bolt, stamped U. S. G. S., 458, N. Y.

[Latitude, 42° 35′ 16″.65. Longitude, 78° 52′ 37″.69.]

TO STATION.	Azimuth			Back Azimuth.			Log Dist
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Pierce	53	28	02.2	233	16	45.7	4.45452
Sheflin	103	12	33.2	333	07	13.0	4.04439

DEAN.

One mile east of Silver Creek depot, Chautauqua county, N. Y., just outside of corporation limits, on highest ground in immediate vicinity. Station about 150 feet north of main east and west road on line running east and west, separating property of George Dean and Dr. Evarts.

Permanent mark: Stone monument, copper bolt, stamped U. S. G. S., 460, N. Y.

[Latitude, 43° 32′ 33″.61. Longitude, 79° 09′ 15″.62.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Pierce	0	21	05.2	180	21	03.0	4.07774
Deering	29	05	39.7	209	02	04.8	4.15428
Sheflin	237	41	58.0	57	47	53.1	4.15089

SILVER CREEK.

Triangulation point of the United States Lake Survey in Sheridan township, Chautauqua county, N. Y., three miles west of village of Silver Creek, three-quarters of a mile east of Sheridan railroad station. A new railroad has cut through primary station, destroying center mark. A new station was established about 75 feet south of railroad track in open field.

Permanent mark: Stone monument marked U. S. Reference stone, monument north 58 degrees and eight seconds, east 283.9 feet.

[Latitude, 42° 31′ 13″.34. Longitude, 79° 13′ 27″.28.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Deering	6	45	07.2	186	44	32.3	4.00263
Brooks Chimney	64	31	29.4	244	27	26.9	4.95879
Dunkirk, L. H	74	38	49.2	254	33	33.0	4.045157
Pierce	329	04	40.7	149	07	28.5	4.04343

PIERCE.

Station on a knoll in cultivated field, in town of Villenova, Chautauqua county, N. Y., about 50 yards south of Hanover line, close by main road to Forestville. L. J. Pierce, owner. L. J. Geer, lives on place.

Permanent mark: Cut marble post 8 by 8 by 30 inches flush with ground. Copper bolt stamped U. S. G. S., 457, N Y.

[Latitude, 42° 26′ 06″.00. Longitude, 79° 09′ 18″.82.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Deering	85	47	06.4	275	48	43.8	3.88766
Silver Creek	149	07	28.5	329	04	40.7	4.04848
Richmond	233	16	45.7	53	28	02.2	4.45452
Sheflin	211	39	18.2	31	45	15.2	4.36058
Dean	180	21	03 0	0	21	05.2	4.07774

DUNKIRK, LIGHTHOUSE.

Triangulation point of the United States Lake Survey, situated one and one-quarter miles northwest of city of Dunkirk, Chautauqua county, N. Y. Instrument on iron platform about 35 feet above ground.

Permanent mark: Center of brick tower.

[Latitude, 42° 29′ 37″.80. Longitude, 79° 21′ 15″.80.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Silver Creek	254	33	33.0	74	38	49.2	4.045157
Deering	306	27	36.1	126	32	17.5	4.07358

COOPER.

Triangulation point of the United States Lake Survey. Station one-quarter of a mile from end of Peninsula Point, Jefferson county, N. Y., and nearly west of Sacketts Harbor in cultivated field.

Permanent mark: Hole drilled in stone post one foot below surface.

Reference post, south 68 degrees, west 36.0 meters.

Reference post, north 73 degrees, east 52.0 meters.

Reference post, north 24 degrees, east 62.5 meters.

[Latitude, 43° 57′ 48″.2. Longitude, 76° 16′ 41″.5.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Horse Island	281	57	39.4	102	03	11.5	4.087718
Hovey	338	51	49.1	158	53	34.2	3.972121
Greene	287	34	30.8	107	53	46.9	4.591839

GLEASON.

Triangulation point of the United States Lake Survey. Station four miles northeast of Stony Point lighthouse, about one and three-eighths miles southwest of the west end of Snowshoe Bay, Jefferson county, N. Y.

Permanent mark: Triangular hole drilled in bed rock one foot below surface. A surface stone is planted directly over it.

[Latitude, 43° 52′ 48″.9. Longitude, 76° 16′ 41″.5.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Horse Island	232	38	31.0	52	43	15.0	4.060565

HOVEY.

In town of Henderson, Jefferson county, N. Y., on flat bluff on west side of Henderson Bay, in cleared pasture with fringe of timber around edge of bluff. Land owned by Mr. Hovey, who lives half a mile northeast of station. The mark is a hole drilled in solid rock one foot below surface. Surface mark, a boulder set over center with a cross cut a half-inch deep on its top.

[Latitude, 43° 53′ 04″.77. Longitude, 76° 14′ 09″.99.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Johnson	256	04	34.99	76	20	57.66	4.512470
Horse Island	228	21	33.99	48	25	20.75	3.989328
Cooper	158	53	34.19	338	51	49.10	3.972121
Greene	275	10	40.49	95	28	11.39	4.531514
Carl	274	03	13.99	94	22	06.34	4.563231

CARL.

A round bare hill three-fourths of a mile northeast of Cronk Corners, Lewis county, N. Y., owned by Thomas Carl.

Permanent mark: Stone monument, copper bolt stamped U. S. G. S., 499, N. Y. Stones piled around monument.

[Latitude, 43° 51′ 37″.67. Longitude, 75° 46′ 56″.10.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Greene	79	54	50.30	259	53	28.80	3.426338
Johnson	155	07	25.60	335	04	55.00	4.061204
Boynton	109	35	50.80	289	29	46.90	4.094678
Hovey	94	22	06.34	274	03	13.99	4.563231

GREENE.

A cleared ridge in town of Pinckney, Lewis county, N. Y., in lot 30, Franklin Greene owner, 2 1-2 miles east-southeast of Whitesville.

Permanent mark: Stone monument, in which a copper bolt stamped U. S. G. S., 488, N. Y.

[Latitude, 43° 51′ 22″.53. Longitude, 75° 48′ 53″.76.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Cooper	107	53	46.90	287	34	30.30	4.591839
Johnson	168	29	45.60	348	28	36.50	4.046701
Carl	259	53	28.80	79	54	50.30	3.426338
Hovey	95	28	11.39	275	10	40.49	4.531514

BOYNTON.

Station on cleared ridge, five miles south of Watertown, Jefferson county, N. Y., owned by Lester Boynton. Highest land within six or eight miles.

Permanent mark: Stone monument four feet long; in which is a copper bolt stamped U. S. G. S., 450, N. Y.

[Latitude, 43° 53′ 52″.46. Longitude, 75° 55′ 41″.02]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Carl	289	29	46.9	109	35	50.8	4.094678
Buckminster	160	34	41.1	340	32	05.0	4.177686
Horse Island	106	05	15.3	285	56	12.8	4.258931
Johnson	227	29	42.6	47	33	16.1	3.968754

LOOMIS.

Triangulation point of the United States Coast and Geodetic Survey station is situated near the village of Palermo, Oswego county, N. Y., about four-fifths of a mile south-southwest from "Jennings Corner" or "Palermo Center," on land owned by Mr. J. W. K. Loomis.

Permanent mark: An apothecary's short-neck bottle filled with ashes 30 inches below surface; a marble post 30 inches long rests on the bottle with letters U. S. C. S. upon its top. Four other posts are set with centers, each five feet north, south, east and west (true) from the station.

[Latitude, 43° 21′ 18″.46. Longitude, 76° 17′ 10″.37.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Florence	265	44	53.68	86	10	41.57	4.7064895
Fenner	314	53	10.34	135	15	27.12	4.7960549

JOHNSON.

A bare summit on edge of table-land, four miles southeast of Watertown, Jefferson county, N. Y.

Permanent mark: Copper bolt in solid rock, stamped U. S. G. S., 451, N. Y.

[Latitude, 43° 57′ 16″.05. Longitude, 75° 50′ 33″.36.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Carl	335	04	55.00	155	07	25.60	4.061204
Greene	348	28	36.50	168	29	45.60	4.046701
Boynton	47	33	16 10	227	29	42.60	3.968754
Seeber	140	59	02.60	320	51	50.60	4.341508
Miller	192	18	14.20	12	21	50.70	4.510670
Pamelia	169	50	50.70	349	49	26.30	4.185362
Buckminster	128	44	54.60	308	38	44.70	4.154169
Horse Island	87	05	51.00	266	53	14.70	4.386219
Hovey	76	20	57.66	256	04	34.99	4.512470

HORSE ISLAND.

Lighthouse on Horse Island, Sacketts Harbor, Jefferson county, N. Y., one-half mile from village. Instrument on iron platform about 80 feet above ground, outside of lenses.

Permanent mark: Center of brick tower.

[Latitude, 43° 56′ 34″.70. Longitude, 76° 08′ 43″.00.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Johnson	266	53	14.7	87	05	51.0	4.386219
Boynton	285	56	12.8	106	05	15.3	4.258931
Hovey	48	25	22.8	228	21	36.0	3.989328
Buckminster	233	26	50.1	53	33	17.1	4.188920
Cooper	102	03	11.5	281	57	39.4	4.037718
Gleason	52	43	15.0	232	38	31.0	4.060565

BUCKMINSTER.

Two miles north of Brownville, Jefferson county, N. Y., on highest land within several miles.

Permanent mark: Stone monument three feet long set in shale rock two feet east of stone fence. Copper bolt in top stamped U. S. G. S., 446, N. Y.

[Latitude, 44° 01′ 32″.44. Longitude, 75° 59′ 25″.80.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Johnson	303	38	44.7	123	44	54.6	4.154169
Boynton	340	32	05.0	160	34	41.1	4.177686
Horse Island	53	33	17.1	223	26	50.1	4.188920
Seeber	167	46	24.7	347	45	22.9	3.970462

PAMELIA.

Station in field north of road leading west from Pamelia Four Corners, Jefferson county, N. Y., about one-third of a mile from the Corners on land belonging to David Countryman.

Permanent mark: Copper bolt in bowlder stamped U. S. G. S., 453, N. Y.

Station to hickory tree (blazed) northeast, 55.8 feet.

Station to hickory tree (blazed) east, 27.8 feet.

Station to arrowhead in bowlder northwest, 12.0 feet.

Station to arrowhead in bowlder west, 8.0 feet.

[Latitude, 44° 05′ 24″.76. Longitude, 76° 52′ 34″.78.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Miller	210	03	54.8	30	08	56.2	4.282475
Johnson	349	49	26.3	169	50	50.7	4.185362
Seeber	100	02	30.5	279	56	42.5	4.052824

SEEBER.

In Clayton township, two and one-half miles west of Stone Mills, three miles north of Perch River, Jefferson county, N. Y., 400 yards north of house of Walter Seeber, just inside of fence on east side of road and on edge of grain field.

Permanent mark: Stone monument, copper bolt in top stamped U. S. G. S., 454, N. Y. Distance to small tree near rail fence to northward, 264 feet.

[Latitude, 44° 06′ 28″.26. Longitude, 76° 00′ 54″.81.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Pamelia	279	56	42.5	100	02	30.5	4.052824
Johnson	320	51	50.6	140	59	02.6	4.341508
Buckminster	347	45	22.9	167	46	24.7	3.970462

MILLER.

Three miles northeast of Theresa village, Jefferson county, N. Y., on higest land within many miles.

Permanent mark: Copper bolt in bowlder, stamped U. S. G. S., 452, N. Y.

[Latitude, 47° 14′ 21″.87. Longitude, 75° 45′ 22″.13.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg	Min.	Sec.	Deg	Min.	Sec.	Meters.
Johnson	12	21	50.7	192	18	14.2	4.510670
Pamelia	30	08	56.2	210	03	54.8	4.282474

COLWELL.

In Ellisburg, Jefferson county, N. Y., four miles southwest of Ellisburg village, three-fourths mile east of Lake Ontario, on land owned by Hamilton Colwell, Jr., 150 yards west of his residence.

Permanent mark: Cut marble post 8 by 8 by 30 inches, set flush with surface. Copper bolt, stamped U. S. G. S., 437, N. Y.

[Latitude, 43° 41′ 40″.56. Longitude, 76° 11′ 10″.78.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg.	Min	Sec	Meters.
Lowrey	269	08	15.4	89	16	01.5	4.179366
Sandy Creek	304	57	38.7	125	01	07.4	3.917406
Dyke	13	13	00.8	193	10	46.5	4.279946
Thomas	308	20	09.4	128	28	37.7	4.3236[illegible]2

MANNSVILLE.

Triangular point of the United States Lake Survey, situated in Mannsville, Jefferson county, N. Y., one-half mile northeast of the village of Mannsville; in lot 177, Ellisburg township, on highest ground in the vicinity.

Permanent mark: Marble post one and one-half feet below surface. Reference posts — one north 67 degrees 48 minutes east, distant 91.79 meters; one south 54 degrees 30 minutes east, distant 107.84 meters; one south 34 degrees 6 minutes west, distant 393.1 meters.

[Latitude, 43° 12′ 54″.41. Longitude, 76° 03′ 14″.61.]

TO STATION.	AZIMUTH			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg	Min.	Sec.	Meters.
Sandy Creek	29	01	28.36	208	59	28.34	3.904569
Oswego	51	05	31.07	230	46	29.63	4.679876
South Base	52	25	20.85	232	19	23.89	4.164962
North Base	71	10	47.73	251	04	43.36	4.096264
Stony Point	127	29	58.81	307	20	08.21	4.380805
Colwell	77	58	48.70	257	53	19.70	4.037532
Lowrey	294	55	22.20	114	57	39.50	3.690725

LOWREY.

In Oswego county, N. Y., one-half mile south of Jefferson county line, 4 miles from Mannsville, six miles from Sandy Creek, in field of James E. Lowrey, one-third of a mile south of his house.

Permanent mark: Dressed stone with copper bolt in center of top, stamped U. S. G. S., 439, N. Y.

[Latitude, 43°, 41″ 47″.37. Longitude, 75° 59′ 55″.94.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Mannsville	114	57	39.5	294	55	22.2	3.690725
Colwell	89	16	01.5	269	08	15.4	4.179366
Sandy Creek	59	20	57.2	239	16	40.0	3.986883
Dyke	46	10	02.4	226	00	03.6	4.432104

SANDY CREEK.

Triangulation point of the United States Lake Survey. Station in Sandy Creek township, Oswego county, N. Y., one mile northwest of village of Sandy Creek. Land owned by Jacob Hadley, who lives 300 feet east of station.

Permanent mark: Dressed stone one foot below surface.

[Latitude, 43° 39′ 06″.93. Longitude, 76° 06′ 08″.40.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Lowrey	239	16	40.00	59	20	57.20	3.986888
Colwell	125	01	07.40	304	57	38.70	3.917406
Mannsville	208	59	28.34	29	01	23.36	3.904569

THOMAS.

Station on cleared hill three-fourths of a mile east of Orwell village, Oswego county, N. Y., 300 yards south of main east and west road, in a cultivated field belonging to George Thomas, hotelkeeper at Orwell.

Permanent mark: Dressed stone set eight inches below surface, copper bolt in top stamped U. S. G. S., 438, N. Y. White ash tree north 13 degrees 34 minutes west 117.3 feet; dressed stone north 83 degrees 48 minutes east 241.8 feet.

[Latitude, 43° 34′ 36″.42. Longitude, 75° 58′ 54″.09.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Dyke	75	26	38.1	255	15	56.9	4.334257
Colwell	128	28	37.7	308	20	09.4	4.323686

DYKE.

In town of Mexico, Oswego county, N. Y., four miles from the village, in a cleared field on shores of Mexico bay, 100 yards from water's edge, and about 100 yards from Richmond town line. Denny Dyke, owner of land.

Permanent mark: Stone set two feet in ground; projects six inches; copper bolt in stone stamped U. S. G. S., 436, N. Y.

[Latitude, 43° 31′ 39″.54. Longitude, 76° 14′ 24″.76.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Colwell	193	10	46.5	13	13	00.3	4.279942
Lowrey	226	00	03.6	46	10	02.4	4.432104
Thomas	225	15	56.9	75	26	38.1	4.384257

MOORE.

Seven miles northwest of Ellenburgh Depot, Clinton county, N. Y., one mile east of Clinton Mills, in field of James Moore, one-fourth of a mile north of his house. Summit of flat hill.

Permanent mark: A copper bolt, four inches long and one inch in diameter, sunk in solid rock; top of bolt stamped U. S. G. S., 431, N. Y.

[Latitude, 44° 57′ 53″.71. Longitude, 73° 51′ 36″.52.]

TO STATION.	Azimuth			Back Azimuth.			Log. Dist
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Haseltine	20	31	03.6	200	27	59.8	4.212828
Cherubusco	78	18	11.1	258	15	08.9	3.762444
West Hill	36	43	00.5	216	38	07.9	4.182583
Dannemora	335	16	43.9	152	22	49.9	4.436154
Lyon	0	31	50.1	180	31	50.5	4.461256

CHERUBUSCO.

Station in center of tower of St. Philominus Catholic Church, Cherubusco, Clinton county, N. Y. Tower is solid masonry. Instrument placed in belfry, about 55 feet above ground.

Permanent mark: A copper bolt let into a timber of floor of belfry, stamped U. S. G. S., 434, N. Y.

[Latitude, 44° 57′ 15″.63. Longitude, 73° 55′ 15″.03.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Haseltine	0	10	13.2	180	10	11.9	4.149718
West Hill	17	14	52.7	197	13	02.6	4.062777
Moore	258	15	08.9	78	18	11.1	3.762444
Lyon	348	56	32.8	168	59	25.9	4.451317

WEST HILL.

Not occupied. In Ellenburgh township, three and one-half miles west of Ellenburgh Center, Clinton county, N. Y. Station on highest part of flat wooded summit, on land owned by Peter Kent, near a pile of loose rock four feet high, 15 feet in diameter.

Permanent mark: Stone monument of usual form, copper bolt in top, stamped U. S. G. S., 433, N. Y.

[Latitude, 44° 51′ 18″.11. Longitude, 73° 58′ 31″.08.]

TO STATION.	AZIMUTH			BACK AZIMUTH.			LOG. DIST.
	Deg	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Moore	216	38	07.9	36	43	00.5	4.182583
Haseltine	312	16	33.6	132	18	22.4	3.660504
Cherubusco	197	13	02.6	17	14	52.7	4.062777

HASELTINE.

In Clinton county, N. Y., three and one-half miles southwest of Ellenburgh Center, on land owned by heirs of John W. Haseltine, one-half mile south of house of Adin Haseltine. Summit is rounded and clear of timber.

Permanent mark: Stone monument four feet long, six inches square at top; copper bolt in top, stamped U. S. G. S., 432, N. Y.

[Latitude, 44° 49′ 38″.34. Longitude, 73° 55′ 56″.95.]

TO STATION.	AZIMUTH			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min	Sec.	Deg	Min.	Sec.	Meters.
Upton	237	35	34.6	57	52	30.7	4.572074
Lyon	338	09	06.9	158	12	01.6	4.166817
Moore	200	27	59.8	20	31	03.6	4.212828
Cherubusco	180	10	11.9	0	10	13.2	4.149718
West Hill	132	18	22.4	312	16	33.6	3 660504
Covey	208	04	53.1	28	10	50.9	4.372419

DANNEMORA.

Triangulation point of the U. S. C. & G. S. Station on eastern summit of Dannemora mountain, Clinton county, N. Y., one and one-half miles northeast of village of Dannemora. The broad

summit was cleared of timber, except to the northwest. Theodolite was elevated on tripod 22 feet high.

Permanent mark: An iron bolt in solid rock, one foot below surface of ground.

[Latitude, 40° 44′ 30″.04. Longitude, 73° 42′ 57″.60.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg.	Min	Sec.	Meters.
Moore	155	22	49.9	335	16	43.9	4.436154
Covey	168	51	38.1	348	48	25.8	4.489897
Upton	206	07	47.9	26	15	33.6	4.516202
Lyon	70	39	32.1	250	38	18.3	4.093158

UPTON.

Two miles west northwest of Perry Mills, Clinton county, N. Y., one-half mile north of schoolhouse, where north and south road crosses international boundary line between New York and Canada.

Permanent mark: Iron boundary post projecting three and one-half feet above ground.

[Latitude, 45° 00′ 24″.10. Longitude, 73° 31′ 57″.65.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg	Min.	Sec.	Meters.
Lyon	38	02	38.5	217	48	38.4	4.628909
Covey	92	30	06.6	272	19	06.8	4.310466
Haseltine	57	52	30.7	237	25	34.6	4.572074
Dannemora	26	15	33.6	206	07	47.9	4.516202

COVEY, CANADA.

Not occupied. One mile north of international boundary line between New York and Canada, two miles west of Covey Hill. Station on southeast end of ridge, 200 feet lower than summit, 300 yards south of main east and west road, in field 500 feet southeast of house of John Waddell.

Permanent mark: A pole in center of a pile of rocks five feet high and 30 feet in diameter.

[Latitude, 45° 00′ 51″.89. Longitude, 73° 47′ 30″.18.]

To Station.	Azimuth.			Back Azimuth.			Log Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Lyon	9	23	27.7	189	20	25.2	4.542663
Haseltine	28	10	50.9	208	04	53.1	4.372419
Upton	272	19	06.8	92	30	06.6	4.310466
Dannemora	348	48	25.8	168	51	38.1	4.489897

Lyon.

Triangulation station (Mount Lyon, 2), of the U. S. C. & G. S. Station on northeast rocky bluff of summit. The broad wooded summit cuts off the view to the southwest. The top was reached by trail from Lyon Mountain station, Clinton county, N. Y., a distance of three and one-half or four miles.

Permanent mark: A copper bolt in solid rock, marked V. C., Adirondack Survey, 1876.

[Latitude, 44° 42′ 16″.74. Longitude, 73° 51′ 48″.74.]

To Station.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Haseltine	158	12	01.6	338	09	06.9	4.166817
Churubusco	168	59	25.9	348	56	32.3	4.451317
Moore	180	31	50.5	0	31	59.1	4.461256
Dannemora	250	33	18.3	70	39	32.1	4.093158
Upton	217	48	33.4	38	02	33.5	4.628909
Covey	180	29	25.2	9	23	27.7	4.542663

Birch.

In northwest corner of town of Hebron, Washington county, N. Y., eight miles southwest of Granville, one mile northwest of North Hebron. Station on land owned by John Brown, living on west side of hill. Summit flat, but cleared of timber.

[Latitude, 43° 20′ 18″.94. Longitude, 73° 20′ 11″.01.]

To Station.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Rupert	287	06	54.5	107	12	31.1	4.063265
Rascal	32	37	24.8	212	34	36.5	4.010145

RASCAL.

In western part of town of Hebron, Washington county, N. Y., very close to Argyle line, a cleared summit of ridge, giving a good view in all directions except northwest. Land owned by James A. McNeil, who lives on west side. Station 10 miles from Salem, four miles northwest of West Hebron.

[Latitude, 43° 15′ 39″.49. Longitude, 73° 24′ 15″.68.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Rupert	252	28	52.8	72	37	16.9	4.239952
Jackson	358	56	28.7	178	56	40.0	4.307820
Birch	212	34	36.5	32	37	24.3	4.010145

GREENWICH.

Triangulation station of the United States coast and Geodetic Survey. Station four and one-half miles north of village of Greenwich, Washington county, N. Y. Local name is Bald Mountain. Owner is Dennis Sullivan, who lives north of triangulation point. Summit wooded on east and west sides. A comparatively low hill and not a good station.

Permanent mark: Iron bolt in solid rock.

[Latitude, 43° 07′ 35″.12. Longitude, 73° 31′ 30″.61.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Adams	315	06	51.1	135	14	05.0	4.303497
Tilton	......	......	......	......	......	......	4.109687
Jackson	297	40	19.6	117	45	28.1	4.061951
Rafinesque	11	15	46.8	191	12	03.2	4.581978
Rupert	232	32	11.5	52	45	32.6	4.521466

JACKSON.

In central part of town of Jackson, Washington county, N. Y., four miles northwest of Cambridge, from which place it is best reached, seven miles east of the village of Greenwich. Station on highest cleared summit of ridge, on land owned by Robert Allen, who lives one-fourth of a mile southeast.

[Latitude, 43° 04′ 41″.28. Longitude, 73° 2[illegible]′ 59″.08.]

TO STATION.	Azimuth.			Back Azimuth.			Log Dist.
	Deg	Min.	Sec.	Deg.	Min	Sec.	Meters.
Tilton	40	32	45.9	220	29	54.4	3.942186
Greenwich	117	45	28.1	297	40	19.6	4.061951
Rascal	178	56	40.0	358	56	28.7	4.307820
Rupert	212	22	47.2	32	30	59.1	4.480633

Tilton.

Seven miles south of Greenwich, Washington county, N. Y., one mile east of Summit railroad station. Mr. Thomas, owner, lives on north side. Leonard Tingue lives on south side. Top is entirely cleared of timber.

[Latitude, 43° 01′ 05″.64. Longitude, 73° 28′ 10″.40.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec	Deg.	Min.	Sec.	Meters.
Adams	283	03	51.0	103	08	41.8	3.996239
Rafinesque	25	16	47.3	255	10	47.6	4.449087
Greenwich	.....	....	.....	......	......	....	4.108687
Jackson	220	29	54.4	40	32	45.9	3.942186

Rupert.

A bold summit, four miles north of Rupert village, Rutland county, Vt., and three and one-half miles south of Pawlet; 10 miles southeast of Granville, via Pawlet; road from Pawlet to Rupert passes just east of station. Land owned by James Jennings, who lives one-third of a mile south of station.

Signal: A small tree with tuft of brush at top and white flag below.

[Latitude, 43° 18′ 28″.33. Longitude, 73° 12′ 00″.46.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters
Jackson	32	30	59.1	212	22	47.2	4.480633
Greenwich	52	45	32.8	232	32	11.5	4.521466

ADAMS.

In town of White Creek, Washington county, N. Y.; local name, Mount Tom, James Adams, owner. Sullivan Center lies one-half mile northeast of station, which is in a cleared field on highest part of summit. Some timber on south end of hill. Best reached from Cambridge.

[Latitude, 42° 59′ 52″.82. Longitude, 73° 21′ 04″.00.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Rafinesque	48	08	13.3	222	57	28.4	4.501584
Becker	90	45	39.5	270	38	25.4	4.158979
Greenwich	135	14	05.0	315	06	51.1	4.303497
Tilton	103	08	41.8	283	03	51.0	3.996239

BECKER.

In town of Easton, Washington county, N. Y., eight miles south of Greenwich, three miles west of Summit station. Owner, James E. Becker, living on west side; summit cleared of timber, except a fringe on southern edge.

[Latitude, 42° 59′ 58″.51. Longitude, 73° 31′ 40″.60.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Adams	270	38	25.4	90	45	39.5	4.158979
Rafinesque	......	......	......	......	......	......	4.388452

RAFINESQUE.

Triangulation station of the United States Coast and Geodetic Survey, four miles northeast of Lansingburgh, Rensselaer county, New York; local name, Bald Mountain. Summit bald. Jacob Hayner lives on south side.

Permanent mark: Hole drilled in rock.

[Latitude, 42° 47′ 21″.15. Longitude, 73° 36′ 58″.81.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Greenwich................	191	12	03.2	11	15	46.8	4.581978
Tilton	205	10	47.6	25	16	47.3	4.449087
Adams	222	57	23.4	43	08	13.8	4.501584
Becker	......	......	......	......	......	.....	4.888452

MOUNT MERINO.

Primary triangulation station of the New York State Survey and also of the United States Coast and Geodetic Survey. Situated in Greenport town, Columbia county, N. Y., on a high hill two miles southwest of Hudson.

Permanent mark: Stone monument.

[Latitude, 42° 14′ 05″.06. Longitude, 73° 49′ 03″.54.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Powell.....................	167	25	35.3	347	23	42.8	4.244611
Windham Peak...........	108	26	58.6	288	13	49.8	4.451936

SLIDE MOUNTAIN.

Not occupied. On the highest peak in the Catskill Mountains in Shandaken town, Ulster county, N. Y., eight miles south of Shandaken post-office. Point sighted is an observatory.

[Latitude, 41° 59′ 56″.97. Longitude, 74° 23′ 10″.94.]

TO STATION.	Azimuth			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Vly	170	34	05.6	350	31	52.4	4.443943
Windham Peak..........	209	42	44.8	29	52	31.9	4.606561

VLY.

A high, flat, heavily-wooded summit, five miles west of Lexington, Greene county, N. Y. Instrument mounted on a large birch tree on southeast side of summit, about 50 feet lower than

the highest part of summit. From here can be had in all directions a good view, excepting westward.

Permanent mark: Large birch tree.

[Latitude, 42° 14′ 45″.50. Longitude, 74° 26′ 29″.60.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min	Sec.	Meters.
Pisgah	227	50	09.8	47	58	05.8	4.338470
Windham Peak	252	35	58.1	72	48	00.2	4.410958
Hunter	......	......	......	......	......	......	4.279210
Slide Mt	350	31	52.4	170	34	05.6	4.443943
Utsayantho	144	18	50.3	324	12	50.5	4.321234

HUNTER.

A high, flat, wooded summit, four miles by trial south of Hunter, Greene county, N. Y. An old observatory, 55 feet high, was strengthened and used to mount theodolite on.

[Latitude, 42° 10′ 39″.50. Longitude, 74° 13′ 49″.31.]

TO STATION.	Azimuth			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Vly	......	......	......	......	......	......	4.279210
Pisgah	176	49	01.9	356	48	25.5	4.347189
Windham Peak	205	10	28.1	25	13	58.6	4.226756

UTSAYANTHO.

Not occupied. A primary triangulation station of the New York State survey situated in Stamford town, Delaware county, N. Y.

Point sighted is the new observatory and is some distance from the New York Survey station.

[Latitude, 42° 23′ 56″.72. Longitude, 74° 35′ 24″.02.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg	Min	Sec.	Deg	Min.	Sec.	Meters.
Pisgah	274	42	04.4	94	56	00.8	4.454558
Vly	324	12	50.5	144	18	50.3	4.321234

WINDHAM PEAK.

Station seven miles east of Windham Center, Greene county, N. Y. Best reached by trail, two miles long, from house of M. E. Sherman, who lives on west side. An old observatory, 22 feet high was used to elevate instrument, as the summit of the mountain is flat and heavily wooded.

Permanent mark: Hole drilled in rock with arrowheads cut in rock pointing to center.

[Latitude, 42° 18′ 53″.78. Longitude, 74° 08′ 36″.22.]

TO STATION.	AZIMUTH			BACK AZIMUTH.			LOG DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Hunter	25	18	58.6	205	10	28.1	4.226756
Pisgah	129	39	04.2	309	34	56.9	4.037701
Rundel	206	04	13.1	26	07	56.1	4.286302
Vly	72	48	00.2	252	35	58.1	4.410958
Powell	250	18	26.5	70	24	48.9	4.388157
Slide Mt.	29	52	31.9	209	42	44.8	4.606561

PISGAH.

Seven miles by wagon road north of Windham Center, Greene county, N. Y., and seven miles west-southwest of Durham. Summit entirely bare of timber. Instrument set up in front of hotel and angles reduced to center of cupola.

[Latitude, 42° 22′ 38″.18. Longitude, 74° 14′ 43″.27.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Powell	267	32	25.1	87	47	50.3	4.497277
Merino	......	......	....	......	......	......	4.587360
Windham Peak	309	34	56.9	129	39	04.2	4.037701
Rundell	....	......	......	....	......	......	4.257658
Hunter	356	48	25.5	176	49	01.9	4.347139
Vly	47	58	05.3	227	50	09.8	4.338470
Utsayantho	94	56	00.8	274	42	04.4	4.454558

RUNDELL.

One and one-half miles northwest from Westerlo, Albany county, N. Y. H. H. Rundell, lives on southwest side. O. A. Mabey, owner of land, lives on west side.

[Latitude, 42° 27′ 15″.27. Longitude, 74° 03′ 04″.34.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Windham Peak	26	07	56.5	206	04	18.1	4.286302
Pisgah	.....	.....	.....	.....	.....	.....	4.257658
Powell	295	06	06.3	115	18	41.1	4.231191

POWELL.

Primary triangulation station of the United States Coast and Geodetic Survey, situated on a hill in New Baltimore town, Greene county, N. Y., about three miles northwest of West Coxsackie. Point well known by residents near there.

Permanent mark: Iron cone 18 inches below surface. Pile of rocks above cone.

[Latitude, 42° 23′ 20″.60. Longitude, 73° 51′ 50″.69.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg	Min	Sec.	Deg.	Min.	Sec.	Meters.
Windham Peak	70	24	43.9	250	13	26.5	4.388157
Rundell	115	18	41.1	295	06	06.3	4.231191
Mount Merino	347	23	42.8	167	25	35.3	4.244611

SKY TOP TOWER.

Not occupied. The tower standing on most elevated ground near Lake Mohawk, Ulster county, N. Y., about 15 miles south-southwest of Kingston.

Permanent mark: Center of tower.

[Latitude, 41° 45′ 49″.76. Longitude, 74° 09′ 23″.64.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg	Min.	Sec.	Deg.	Min	Sec.	Meters.
Pink	210	55	12.2	30	59	36.8	4.250418
Kingston City Hall	216	10	16.1	36	16	40.1	4.351719
Boice	235	43	38.3	55	56	53.8	4.521707
Lloyd	253	57	07.3	74	07	53.3	4.366992

KINGSTON CITY HALL.

City Hall, between Kingston and Rondout, Ulster county, N. Y. Instrument mounted on tripod, seven feet high, inside of top of tower.

Permanent mark: Center of tower.

[Latitude, 41° 55′ 37″.46. Longitude, 73° 59′ 47″.90.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Boice	267	47	08.4	87	53	55.4	4.152789
Lloyd	322	13	30.2	142	17	53.0	4.171246
Sky Top Tower	36	16	40.1	216	10	16.1	4.351719
Pink	55	12	23.8	235	10	24.2	3.701074

TRAVER.

Triangulation station of the United States Coast and Geodetic Survey, on land owned by Mr. Traver, two and one-half miles southeast of Rhinebeck village, Dutchess county, N. Y. Highest hill in the vicinity.

Permanent mark: Iron cone two feet below surface.

[Latitude, 41° 55′ 05″.04. Longitude, 73° 52′ 41″.44.]

TO STATION.	AZIMUTH.			BACK AZIMUTH.			LOG. DIST.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Burhams	147	55	31.8	327	52	29.6	4.072218
Upper Red Hook	193	22	23.8	13	23	44.7	4.080424

TERRY.

Triangulation station of the United States Coast and Geodetic Survey, in northeast part of city of Kingston, Ulster county, N. Y., one-fourth of a mile west of river and 309 feet above it, 100 yards from edge of bluff.

Permanent mark: Stone monument one foot square projecting two feet above ground.

[Latitude, 41° 56′ 22″.29. Longitude, 73° 58′ 19″.53.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Lloyd	331	44	29.4	151	47	53.7	4.172733
Prospect	354	36	18.5	174	36	38.3	3.861053
Boice	273	56	11.9	94	02	04.9	4.086314

PROSPECT.

Triangulation station of the United States Coast and Geodetic Survey, in Ulster county, N. Y., on a rounded hill, wooded on west side, and cleared on east side, situated three miles south of Rondout and east of the northern Esopus ponds. Amaziah Niese, owner of land.

Permanent mark: Iron cone with rock piled around it.

[Latitude, 41° 52′ 27″.96. Longitude, 73° 57′ 49″.92.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Terry	174	36	38.3	354	36	18.5	3.861053
Lloyd	312	44	37.6	132	47	41.6	3.987784
Boice	240	54	40.1	61	00	13.0	4.118791
Barnes	309	37	05.2	129	41	38.0	4.088583

BOICE.

In Dutchess county, N. Y., in southwest corner of town of Milan. Station on high, bare hill, one-half mile north of Enterprise, almost on Rhinebeck town line; six miles by road east of Rhinebeck village.

Permanent mark of United States Coast and Geodetic Survey could not be found.

Reference mark: Blazed chestnut tree south 1 degree and 15 minutes west (true) 109.3 feet.

[Latitude of new station, 41° 55′ 54″.81. Longitude, 73° 49′ 31″.30.]

TO STATION	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Prospect	61	00	13.0	240	54	40.1	4.118791
Terry	94	02	04.9	273	56	11.9	4.086314
Lloyd	22	45	13.4	202	42	44.6	4.123825
Kingston City Hall	87	53	55.4	267	47	03.4	4.152789
Hussey Hill	69	59	36.5	249	52	49.4	4.17470
Sky Top Tower	55	56	53.8	235	43	38.3	4.521707
Pink	79	33	25.4	259	24	33.9	4.270619

LLOYD.

Triangulation station of the United States Coast and Geodetic Survey, in Dutchess county, N. Y., in eastern part of town of Hyde Park, three and one-half miles northeast of village, and eight miles southeast of Staatsburg.

Permanent mark: Iron cone just below surface.

[Latitude, 41° 49′ 17″.24. Longitude, 73° 53′ 14″.19.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Prospect	132	47	41.6	312	44	37.6	3.937784
Boice	202	42	44.6	22	45	13.4	4.123825
Terry	151	47	58.7	331	44	29.4	4.172733
Kingston City Hall	142	17	53.0	322	13	30.2	4.171246
Hussey Hill	128	42	24.5	308	38	06.6	4.05768
Sky Top Tower	74	07	53.3	253	57	07.3	4.366992

PINK.

In town of Hurley, Greene county, N. Y., one-eighth of a mile southwest of corner of Ulster and Rosendale. Three miles southwest of Kingston, on highest land in vicinity. Summit nearly cleared of timber. J. M. Pink, owner of land.

Permanent mark: Stone monument; copper bolt stamped U. S. G. S., 463, N. Y.

Distance to large chestnut tree southwest, 29 feet; distance to property line southward, 17.7 feet.

[Latitude, 41° 54′ 04″.50. Longitude, 74° 02′ 46″.89.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Kingston City Hall........	235	10	24.2	55	12	28.8	3.701074
Boice......................	259	24	33.9	79	33	25.4	4.270619
Hussey Hill............ ...	291	52	47.9	111	54	52.3	3.66530
Sky Top Tower	30	59	36.8	210	55	12.2	4.250418

HUSSEY HILL.

Not occupied. In Ulster county, N. Y., about two miles south of Rondout. A high wooded ridge, with some timber cut down on summit.

Permanent mark: A lone tree in gap in timber.

[Latitude, 41° 53′ 08″.54. Longitude, 73° 59′ 40″.69.]

TO STATION.	Azimuth.			Back Azimuth.			Log. Dist.
	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Meters.
Pink	111	54	52.3	291	52	47.9	3.66530
Boice	249	52	49.4	69	59	36.5	4.17470
Lloyd	308	38	06.6	128	42	24.5	4.05768

Topographic Map of New York.

The purpose of all surveys is two-fold; first, to acquire certain information relating to the earth; and, second, to spread this information among the people for whom it is acquired. The acquirement of this information is the field survey; the dissemination may be in the form of manuscript or illustrations, as is the case with geodetic surveys, or of explorations; or the result may be a map, as is the case with topographic surveys, when the map is the only result.

Surveys may be grouped under three general heads:

1. Those made for general purposes, or information surveys.
2. Those made for jurisdictional purposes, or boundary surveys.
3. Those made for construction purposes, or improvement surveys.

Information surveys may be geodetic, geologic, topographic, agricultural, magnetic or nautical. Boundary surveys may be for defining political boundaries, or for defining private property boundaries. Improvement surveys may be made for the construction and improvement of military works, as forts, navy-yards, etc.; for constructing routes of communication, as roads, electric lines, canals; for reclamation of land, as irrigation and swamp surveys; for the improvement of natural waterways, as river and harbor surveys; for supply and sanitation of cities, as city water supply and mill supply surveys, or surveys for the disposal of sewage.

The mother map, or that from which all others are derived, is the topographic map. This is made from nature in the field by measures and sketches recorded on the spot. It is the original or base map from which can be constructed any variety of maps for the serving of separate purposes. The historian may desire to make a map which will indicate the spots upon which were once fought great battles, or on which are situated the ancestral estates of historical families. The geologist may desire to indicate the locations of certain rock formations as they occur upon the surface of the earth. The promoter of railways or other engineering projects may desire to represent the routes which will be covered by his lines of road, or by certain city water-works, plans or real estate subdivisions. For these several purposes the topographic or base map furnishes the original data on which can be indicated in separate colors, on the same or on any reduced scale, information which any of these individuals may desire to express.

For the purposes of the government or State, good topographic maps are invaluable. They furnish the data from which the congressman or the legislator can intelligently discover most of the information bearing directly upon the problem in hand, and they give the committees great assistance in their decisions as to the needs of legislation. If a river and harbor bill is before Congress, or a bill relating to State canals before the Legislature, by an inspection of such maps, the slopes of the country through which the canal or in which the improvements are to be made

may be readily ascertained. The sources of water supply for the canal or river may be accurately measured on such a map and their relation to the work in hand intelligently ascertained. If the war department of the government or the Adjutant-General's office of the State desires to locate an arsenal, encampment ground, or other military work, or, above all, if it is to conduct active military operations in the field, such maps serve, practically, all the purposes of the best military maps. With the addition of a very little field work during war times, such as the indication of fence lines, outbuildings, etc., on the mother or topographic map, a perfect military map is obtained. For the government post-office department, or stage, express or telelgraph companies, such maps furnish the basis on which an accurate understanding can be had of contracts submitted for star routes or other routes for the carrying of mails or packages. As these maps show the undulations of the surfaces over which roads pass, their bends and the relative differences in length, the difficulties in travel on competing roads can be readily ascertained from them. The land departments of the government and State can discover on such maps not only the outlines of the property under their jurisdiction, but its surface formation. Forestry boards can see indicated upon these maps the outlines of the various wooded areas, besides the slopes of the lands on which these woods are situated, their relation to highways of transportation, railways or streams, and the slopes to be encountered in passing through the woods to these highways. The legal department of the government or State finds these maps of service in discussing political or property boundary lines, in ascertaining within what political division crimes are committed, or individuals reside with whom the officers of the law desire to communicate. It is difficult to see how any systematic or economic plan of road improvement can be advantageously made without the knowledge of existing grades, the physiography of the district through which the roads pass, and the location of quarries, which such maps present.

Such maps are of use, then, to legislators, to educators, to military departments, to engineers, to map publishers and to the citizen. No such maps as these are yet in existence in the

State of New York. Special surveys have been made of many portions of the State — a piece along the line of a railway, or a portion of the Hudson river, or some special map for city water supply.

The whole system of making successive special surveys or maps for every new need is one of the most wasteful in our present practice, nor can it be otherwise until one survey shall be made that answers all important public uses. As much money has been expended in making small maps of numerous cities and villages as would have served to map, on the general scale, many times the area of New York State. Even when we have these special maps, they do not fully answer the purpose for which they are intended, as they only show the small area included within the immediate plan of operations. The value of a stream for economic purposes can not be fully ascertained by an examination of the stream at the point from which it is to be used, but the drainage basin, from which it derives its supply, should be surveyed, and its area and slopes be known. A good topographical map not only shows the relations between the natural and artificial features in the immediate neighborhood under consideration, but it shows the relations of these to the surrounding country.

All civilized nations appreciate the value and necessity of good topographic maps of their territory. The principal nations of Europe have completed, or are now engaged upon, surveys that will generally subserve the purposes of topographic maps. These European surveys are all based upon a computed triangulation and are usually made upon a scale not far from one mile to one inch, or 1.63360.

Their scales range between one mile for Great Britain, up through Austria, France, Norway, Germany and Russia, to two miles in the latter country. And from Great Britain they range down with larger scales, through Sweden, Italy, Spain, Denmark and Switzerland, the scale for the latter being a little larger than two inches to one mile.

The lesson taught by the maps of these countries is conceived to be of value in determining the scale which should be adopted for a general topographic map, and as a result the scale chosen is approximately one mile to one inch. It is believed that this

scale affords the best opportunity for the expression of such features as the real estate investor, legislator, or engineer desires to see expressed with some detail, on a general map. If a large scale map is desired, it is usually for a small area, and for this purpose the individual desiring the map would probably make his own special surveys, as they would be conducted with a view to the inauguration of active engineering operations.

The contour interval chosen for the topographic maps of the State of New York, as made on the above scale, is 20 feet vertically. These maps show, in contour lines, printed in brown, the variations in form for every 20 feet in elevation above mean sea level. Whereas a smaller contour interval, five or ten feet, might advantageously be employed upon very level plains and valleys, such an interval would be too small for the expression of steep mountain slopes and valley walls. It has been found that the interval employed gives the best mean value for the expression of all characters of topographic form on the scale chosen, enabling the topagrapher to properly depict the steepest mountain and yet giving a fair idea of the value of the slopes on the more level surfaces.

The features exhibited on topographic maps may be conveniently grouped under the three following heads:

1. The hydrography, or water features, as ponds, streams, lakes.

2. The topography, or surface forms, as hills, valleys, plains.

3. Culture, or the features constructed by man, as cities, roads, villages, and the names printed upon the map.

In order that these various features may be readily distinguishable, one from the other, and thus add legibility to the map, the United States Geological Survey prints the hydrography in blue, the topography in brown and the culture in black. In addition to this, the wood areas are indicated upon the manuscript maps in a uniform green tint.

The object of a topographic survey is the production of a topographic map. Hence the aim of the survey should be to produce only the map; neither time nor money should be wastefully expended in the erection or refined location of monuments on public or private boundary lines, or in the establishment of bench-

marks beyond what is necessitated in the work of obtaining the field data from which to make the map. Special appropriations may be made for the location of monuments and the determination and marking of boundary lines, but such work should be kept distinctly separate from the making of the topographic map. The erection, location and description of boundary marks is the special work of a boundary survey. The erection, description and determination of bench-marks as primary reference marks is the work of a geodetic survey. The determination of many unmarked stations for map-making is the work of a topographic survey.

The mistake is often made of assuming that a topographic map is special and not general. It is the latter, as it is not made for the purpose of constructing roads and highways, though it becomes a very valuable aid in their projection. It is not made for the purposes of reclaiming swamp land or irrigating arid land, but it furnishes information essential to a preliminary study and plan for their improvement. The outcome of a topographic survey being a topographical map, it should be judged by the map, and the map should be judged by the manner in which it serves the general purpose. Above all, of two maps or works of any kind made for the same purpose and serving that purpose equally well, that the one is best which is cheapest is a well recognized principle among engineers. In the prosecution of the topographic work of the Geographical Survey, such primary points are determined geodetically and are properly monumented as are essential to the making of the topographic map. About three such points to an atlas sheet, covering an area of 220 square miles, are so determined and monumented in the State of New York. Such bench-marks are determined and recorded as are obtained in carrying bases for levels over the country. In the State of New York an average of about one bench-mark to four square miles has been located.

To secure the production of uniform work from any hands, it is essential that there should be a criterion to gauge the sufficiency of their surveys. In other words, there should be a standard of comparison for the scale chosen. Such a standard has been set for the work done by the United States Geological Survey in the State of New York, and an examination of the

work done shows the uniformity of its character. This standard agrees in all essential particulars with that adopted by other great government surveys for similar scales. Thus, the topographic map of New York is based upon a computed triangulation, while graphic triangulation only is used to fill in the secondary and tertiary locations. This map represents all roads, both public and private, as well as wood roads and less important farm roads, which are represented in broken dotted lines, as are trails. Roads and water-courses form a framework on which the other details of the survey are sketched. These roads and water-courses are all traversed by actual survey, and are checked between triangulation locations. A close approximation is required in the location of these, but greater latitude is permitted in less important or inaccessible localities. Traveled public roads are generally shown in their true positions, but in wood and by-roads errors of location as large as 200 to 300 feet are permitted, while even greater errors are allowed in the location of mountain paths.

All houses in settlements, as well as in the open country, are carefully located, while large public structures, as granaries, elevators, storehouses, or even barns, when especially prominent, are likewise mapped. The topographic relief is represented in 20-foot contours, and the detail and accuracy of their location differs according to the steepness of the slopes, rarely exceeding in error a curve interval on easy slopes; though greater errors are allowed on steep mountain sides. The elevations of hills, valley floors, passes and ponds are given either from spirit leveling or vertical triangulation within three to five feet. Wood lines are about as carefully mapped as the degree of habitation requires, being generally bounded by roads and located with the same relative accuracy as are these. At present they are not printed on the engraved sheets, being only retained in manuscript until such time as their general publication shall be demanded.

To date, the United States Geological Survey has surveyed about 608,650 square miles, distributed over 49 State and territories. The resulting maps are published on scales varying

between one mile to the inch and four miles to the inch, according to the degree of habitation of the country and the necessity for the maps. The survey of the States of Missouri, Kansas, Virginia, West Virginia and Utah has been almost completed, while portions of nearly every other State in the Union have been or are now being mapped. The States of New Jersey, Massachusetts, Rhode Island and Connecticut have been completely mapped by a system of co-operation between the State Legislatures and the United States Geological Survey similar, in many respects, to the co-operation now existing between the State of New York and the Geological Survey, and the completed maps of these States have been published.

It is not to be supposed that the United States government, nor the State governments which have co-operated with it, would have made such liberal provision for accurate topographic surveys had they not been convinced of their national as well as local importance. The State of New York, so wonderfully diversified in its topographic features and remarkable for the number and size of its cities, is yet almost as noteworthy for the inaccuracy of the few existing maps of its area. Such maps as do exist are chiefly wall maps and county atlases made by private publishers on a very small scale, and are nearly all compiled from very old and inaccurate surveys made with the magnetic compass. While these show, in a general way, the political boundaries within the State and some of the roads, they give no idea whatever of vertical relief. On the maps thus made many important features are omitted altogether. Cross roads and minor streams are left out, and there is no representation of the elevations and depressions of the country; hence, they serve practically few or none of the purposes for which topographic maps are of such value.

The plan on which the United States Geological Survey and the State are now co-operating is, as has been said, similar to that on which the government co-operated with the States of Massachusetts, Rhode Island and Connecticut. Each party to the contract pays half of the expense of conducting the work, and this is put under the immediate direction and control of the government

officers, thus insuring its being carried on in a manner corresponding to that in which the rest of the United States is being mapped. Whereas, the Geological Survey agrees that the cost to the State shall not exceed one-half of $10 per square mile, the actual cost during the past two seasons for mapping 5,850 square miles was at the rate of $4.10 per square mile. For this paltry sum the State of New York not only obtains an accurate survey and mauniscript map of its territory, but it also obtains free of further cost, engraved copper plates from which editions of these maps can be printed and published. Moreover, after the topographic survey is completed, the geologists of the government survey go over the territory thus mapped, and indicate accurately for future publication the various rock formations, and thus furnish a complete scientific map of the geologic formations and the general and local distribution of economic minerals and stones.

The area of the State of New York is nearly 50,000 square miles, and will be mapped on about 258 of the standard atlas sheets of the geological survey. The atlas sheets are approximately 13 by 17 inches, and each full atlas sheet represents an area of about 220 square miles. It is known that the State can be mapped by the geological survey at an average cost of $10 per square mile. The average cost of 10,000 square miles already mapped has been $9.94 per square mile. The 40,000 remaining square miles can be mapped in eight years if the rate of expenditure be the same as last year, $50,000 per annum, of which the State is asked to pay half.

The cost of making these maps is exceedingly small, being far less than that of other government surveys. In spite of this, they are, however, excellent, and their value and accuracy is amply testified to by all who have inspected them in the field. Numerous letters from chief engineers of railroads and from irrigation and hydraulic engineers throughout the country testify to the valuable service which these maps have rendered. More detailed maps, on a larger but more unwieldy scale, might be made if they were deemed desirable, and it were considered wise to incur the additional outlay and to postpone the completion of the work for many years.

The maps, as fast as engraved, are published in small proof editions by the geological survey, and are then issued to such public organizations and individuals as apply for and apear to be in need of them. Their free issuance through the geological survey is thus limited, and does not supply the demands of the public in general. To fill these demands the States of Massachusetts, Rhode Island and Connecticut have received engraved copper plates from the geological survey and have had printed, from transfers therefrom, editions of these maps, which they publish and sell at such a price as returns to the treasuries of those States quite a portion of the money expended in making the original surveys. The cost of publishing the map of the State of Connecticut is about three cents per atlas sheet. Yet the States find a ready sale for these at 25 cents per sheet. Massachusetts has sold at 25 cents per sheet several editions of 1,000 copies each of the maps of her territory, though the cost of publication was a little more than for the Connecticut sheets. It will thus be seen that a large margin of profit may be expected by the State of New York in publishing and selling these maps.

List of Elevations in the State of New York.

The elevations printed in the following list are given to the nearest foot above sea level in New York harbor, and includes nearly all bench-marks which have been used in the making of the topographic map of the State of New York by the United States Geological Survey. Many more elevations have been determined in the course of this work, but only those are here published for which such descriptions can be given as will render them easy of identification.

The list is arranged alphabetically by counties and towns, the elevations determined by spirit level being marked (L) and those by vertical triangulation (T). The probable error of the former is less than one foot; that of the latter is less than five, and generally within three feet. Unless otherwise specified, the elevations are those of the surface of the ground at the point designated. If a water surface, the elevation of mean water level is given; while if a reservoir or dammed running water the elevation is that of the crest of the waste-weir. All eleva-

tions at railway crossings, stations, etc., are those of the top of the rail.

These positions were not determined simply for the purpose of leaving records on the ground for the future use of engineers, but they were obtained at the least cost and only with such accuracy as was required by the topographers in the making of a topographical map in 20-foot contours. While many of these elevations have been determined to the hundredth of a foot, and are indicated on the ground by permanent bench-marks, others are scarcely determined within a foot, and no bench-mark records their position.

STATE OF NEW YORK:

COUNTY OF ALBANY — Town of Bethlehem.

Slingerlands, D. & H. C. Co. R. R., tracks at station	214	L
Wemple, tracks of Albany branch W. S. R. R. at station	91	L
South Bethlehem, West Shore Railroad tracks at station	203	L

COUNTY OF ALBANY — Town of Coeymans.

Blodgett Hill	1,165	T
Coeymans Junction, West Shore Railroad tracks at	180	L

COUNTY OF ALBANY — Town of Guilderland.

Fuller, tracks at station, W. S. R. R.	290	L
Guilderland Center, tracks at station, W. S. R. R	318	L

COUNTY OF ALBANY — Town of New Scotland.

Bennett Hill	1,145	T
Countryman Hill	1,634	T
New Scotland, tracks at station, W. S. R. R.	293	L
Voorheesville, tracks at D. & H. C. Co. R. R.,	326	L
Wolf Hill	1,684	T

COUNTY OF ALBANY — Town of Watervliet.

Cohoes, tracks of D. & H. C. Co., at station.....	95	L
Mohawk Falls, foot...........................	60	L
Mohawk Falls, crest........................	130	L
State Dam, Hohawk river at Cohoes, crest of...	51	L
West Albany, tracks at railroad station, N. Y. C. R. R	197	L

COUNTY OF CHEMUNG — Town of Big Flats.

Beers Hill, south end........................	1,345	T
Big Flats, high summit 1 9-10 miles northwest of.	1,564	T
Big Flats, high summit 2 1-4 miles north of...	1,679	T
Big Flats, high summit 3 1-10 miles north of;		T
also 3-4 miles east of Cuthre Run..........	1,651	T
Big Flats, high summit 2 1-3 miles south of....	1,800	T
Haus Hill, summit 1 1-3 miles west of road forks.	1,699	T
Hendy Creek, high summit 1 mile north of.....	1,632	T
Hendy Creek, high summit 1 1-4 miles northwest of	1,784	T
Hendy Creek, high summit 1 3-4 miles north west of	1,747	T

COUNTY OF CHEMUNG — Town of Catlin.

Beers Hill, north end.......................	1,473	T
Catlin, high summit 3 miles north of; also, 2 1-3 miles east of Lower Pine Valley...........	1,757	T
Martin Hill, summit 1 mile south of..........	1,829	T
Post Creek, summit (Martin Hill) 1 2-3 miles east of	1,888	T
Post Creek, high summit 2 1-10 miles northeast of.	1,902	T
Post Creek, high summit, 1 mile southeast of..	1,865	T
Post Creek, corner of road 1 6-10 miles east of and immediatey north of Martin Hill.......	1,823	T

COUNTY OF CHEMUNG — Town of Elmira.

Big Island, high summit 1 mile east of......	1,388	T
Elmira, Carrs Corners, middle of road	953	L
Elmira, N. Y., L. E. & W. R. R. crossing at Doan & Jones' lumber yard................	875	L
Elmira, top of small bridge over Hiller creek, 1-3 mile north of Carrs Corners............	970	L
Fitch Bridge, high summit 1 1-2 miles northeast of	1,418	T
Reformatory, railroad crossing (N. Y., L. E. & W.) 1-2 mile east of.......................	882	L
Reformatory, railroad crossing (N. Y., L. E. & W.), McCann's boulevard, 1-2 mile northeast of	880	L
Reformatory, top of highest tower	1,101	L
Water Cure, high summit 1 1-4 miles northeast of, and southeast of three road forks	1,498	T

COUNTY OF CHEMUNG — Town of Horseheads.

Carrs Hill, extreme northwest corner of township	1,405	T
Horseheads, N. Y., L. E. & W. station, rail..	903	L
Horseheads, junction of N. Y., L. E. & W., and D., L. & W. R. R. and road, 1 mile south of..	901	L
Horseheads, high summit 2 miles due east of..	1,747	T
Horseheads, high summit 1 1-2 miles northeast of	1,485	T
Horseheads, red barn, southwest corner of roads, 2 2-3 miles east of	1,495	T
North Elmira, N. Y., L. E. & W. R. R. crossing, 1 1-10 miles south of	898	L
North Elmira, rail opposite signal tower of N. Y., L. E. & W. R. R., 1-2 mile south of......	901	L
State Reformatory, yellow barn at corner of roads, 1 1-2 miles northwest of............	1,417	T
State Reformatory, railroad crossing N. Y., L. E. & W., 1 1-4 miles north of..............	890	L

Sullivanville, railroad crossing 1 3-4 miles south of, E. C. & N. track	997	L
Sullivanville, base of large barn, 2 cupolas, at corner roads, 1 2-3 miles south of	1,161	T

COUNTY OF CHEMUNG — Town of Southport.

Fitch Bridge, high summit 1 1-3 miles south of	1,698	T
Hendy Creek, high summit 1 1-2 miles west of	1,787	T
Hendy Creek, corner of roads on county line (Steuben and Chemung), 3 1-2 miles west of; also, 3 9-10 miles north of Pennsylvania-New York State line	1,808	T
Mount Zoar, 1 mile south of Hendy Creek	1,780	T
Rosstown, highest point on "Green Hill," 1 mile east of	1,747	T
Rosstown, high summit 1 1-2 miles southeast of; also, 1-3 mile north of New York and Pennsylvania State line	1,884	T
Rosstown, high summit 3-4 mile south of	1,822	T
Rosstown, high summit 3-4 mile west of	1,765	T
Seely Creek, N. Y., L. E. & W. R. R. station rail	1,039	T
Seely Creek, high summit immediately south of road 2 3-4 miles west of	1,832	T
Southport, high summit 1 1-4 miles south of	1,531	T
Southport, high summit 1 mile north of	1,880	T
Southport, summit (bluff over river) 1 1-2 miles north of	1,129	T
Southport, high summit 1 1-2 miles southwest of	1,360	T
Southport, N. C. R. R. crossing 3-4 mile east of,	872	L
Southport, railroad bridge over Seely Creek, 2-3 mile east of	880	L
Southport, railroad bridge over fork of Seely Creek, 2-3 mile east of	884	L
State Line junction, N. C. R. R.	887	L
Weiss Crossing, 1-2 mile south of Southport on Tioga Branch railroad	901	L

COUNTY OF CHEMUNG — Town of Van Etten.

Spencer Summit, base of white church, road corners 3 miles northwest of	1,803	L

COUNTY OF CLINTON — Town of Altona.

Altona, tracks in front of railroad station	598.96	L
Altona, first railroad crossing west of station,	600.24	L
Altona village, porch of Catholic church	640.00	T
Chazy river, railway tracks at crossing of	577.92	L
Cold Spring brook, railroad tracks crossing, 3-4 mile west of Irona	716.78	L
Forest station, tracks in front of	808.82	L
Goodspeed's stone house, north side of military turnpike, 1-4 mile east of road forks to West Chazy	924.00	L
Graves brook, south branch (second brook west from Irona) railroad tracks	760.74	L
Irona, railroad crossing 1,000 feet east of station	688.83	L
Irona station, tracks in front of	695.97	L
Irona, first railroad crossing west from station,	704.77	L
Irona, second railroad crossing west from station	752.38	L
Jericho, ground at schoolhouse	1,400.00	T
John Dragle's house, north side of Sciota road three miles east of Altona village	600.00	T
Labarge's farm, top of pile of rocks 1,000 feet south of military turnpike, one mile and a half southeast of Forest station	1,020.00	T
Labarge's house, ground at	948.00	T
Labarge's hill top, one mile southwest of	1,230.00	T
Lochren's barn, Murtough Hill	1,170.00	T
Military turnpike, road forks to West Chazy	983.00	L
Military turnpike, high point of land three miles west of road forks to West Chazy	1,099.00	L

Old Gate place, elevation of cross-roads on military turnpike 100 yards west of Chazy river, near	870.00	L
Robinson's tavern (old deserted stone house on north side of military turnpike, 1-4 mile east of Chazy road forks), elevation of roadway	960.00	L
Sciota (house with flag on north side of Altona road, 1 1-2 miles west of Sciota post-office)..	489.00	L
Smithwood brook, military turnpike, at crossing of	833.00	L
Wood's Falls, third railroad crossing west from	544.88	L
Wood's Falls, fourth railroad crossing west from	573.19	L

COUNTY OF CLINTON — Town of Ausable.

Arnold Hill, north mine	930	T
Clintonville, ground in front of steps of Roman Catholic church	594	T
Ferrona	507	L
Keeseville, track at railroad station	403	L
Rogers	578	L

COUNTY OF CLINTON — Town of Beekmantown.

Rand Hill, Verplanck Colvin's signal.........	1,270.00	T
Rand Hill, Coast Survey signal	1,460.00	T
Crossing of Beekmantown-Altona town line on the military turnpike	681.00	L
East Beekmantown	150.00	L

COUNTY OF CLINTON — Town of Black Brook.

Ausable Forks, iron peg, corner of Smith & Prime's drug store	551	L
Black Brook, Roman Catholic church, foot of steeple	1,009	T
Catamount peak	3,168	T

Peru lake (Slush pond)	1,178	T
Middle Kilns, Black Brook-Franklin Falls road,	1,478	L
Palmer's Hill	1,146	T
Toll-house, forks of Black Brook Franklin Falls and Black Brook-Union Falls roads.........	1,405	L
West Kilns, Black Brook and Franklin Falls road	1,678	L

COUNTY OF CLINTON — Town of Champlain.

Central Vermont railroad, first road crossing west of Rouses Point Junction............	131.62	L
Central Vermont railroad, second road crossing west of Rouses Point Junction	191.71	L
Central Vermont railroad, third road crossing west of Rouses Point Junction	218.82	L
Central Vermont railroad, fourth road crossing west of Rouses Point Junction	172.90	L
Central Vermont railroad, fifth road crossing west of Rouses Point Junction	163.64	L
Central Vermont railroad, first road crossing west of Champlain station	158.43	L
Central Vermont railroad, second road crossing west of Champlain station	165.93	L
Central Vermont railroad, third road crossing west of Champlain station	175.18	L
Central Vermont railroad, fourth road crossing west of Champlain station (roadway under bridge)	163.92	L
Central Vermont railroad, fifth road crossing west of Champlain station	174.88	L
Central Vermont railroad, sixth road crossing west of Champlain station (roadway under bridge)	189.68	L
Central Vermont railroad, seventh road crossing west of Champlain station (switch)......	214.21	L
Central Vermont railroad, eighth road crossing west of Champlain station	214.73	L
Champlain, brook east of (water level)........	151.00	L

Champlain, track at railroad station..........	160.83	L
Chazy river, top of dam at first crossing of, by C. V. R. R. going west from Champlain..	170.57	L
Chazy river, at second bridge on C. V. R. R. going west from Champlain	214.41	L
Coopersville, track at railroad station.........	134.00	L
Doods hill, 1 1-2 miles northeast of Champlain,	300.00	L
Rouses Point, C. V. R. R. tracks and road crossing east of C. V. R. R. depot...............	114.49	L
Rouses Point Junction, crossing of D. & H. R. R. and C. V. R. R. tracks..................	124.88	L

COUNTY OF CLINTON — Town of Chazy.

Chazy, tracks in front of railroad station......	151.0	L
Chazy Junction, tracks.....................	257.6	L
Sciota, tracks at railroad station...............	322.6	L
West Chazy, tracks at railroad station........	264.6	L

COUNTY OF CLINTON — Town of Dannemora.

Dannemora mountain, northwest peak, 1-2 mile northeast of Dannemora-Ellenburgh road...	2,210	T

COUNTY OF CLINTON — Town of Ellenburgh.

Ellenburgh, C. V. R. R. crossing of first brook east of	857.04	L
Ellenburgh railroad station	918.14	L
Ellenburgh, road under railroad bridge at....	889.14	L
Ellenburgh, river under railroad bridge at....	886.24	L
Peter Rock's house, 5 miles south of military turnpike, on Ellenburgh-Altona town line road, 1,000 feet west of road..............	1,540.00	T

COUNTY OF CLINTON — Town of Mooers.

Canada line, crossing of Mooers Branch D. & H. R. R. tracks	301.00	L
Cannon's Corners, forks of road 2 1-2 miles north of, and 1 1-2 miles south of Canada line	750.00	T

Central Vermont R. R., O. & C. Div.:

First road crossing west of Mooers Forks, excluding one at railroad station............	400.40	L
Second road crossing west of Mooers Forks...	437.07	L
First road crossing west of Mooers Junction..	284.07	L
Second road crossing west of Mooers Junction,	316.27	L
Third road crossing west of Mooers Junction..	342.50	L
Fourth road crossing west of Moers Junction..	348.74	L
Fifth road crossing west of Mooers Junction..	383.75	L
Ninth road crossing west of Champlain village,	241.76	L
Tenth road crossing west of Champlain village,	267.03	L
Eleventh road crossing west of Champlain village	264.64	L
Imes House, 1 1-2 miles northeast Mooers Forks	370.00	T
Mooers Forks railroad station, track..........	387.75	L
Mooers Junction, D. & H. and C. V. R. R......	279.60	L
Upton triangulation station at road crossing Canada line, 4 miles northeast of Mooers Junction	355.00	T
Weatherspoon Brook, crossing of C. V. R. R..	444.03	L
Woods Falls station, road crossing C. V. R. R., tracks at	485.66	L
Woods Falls, first road crossing west of......	508.47	L
Woods Falls, second road crossing west of, on Mooers-Altona town line.................	518.34	L

COUNTY OF CLINTON — Town of Plattsburgh.

Plattsburgh, railroad tracks in front of station,	120.0	L

COUNTY OF CLINTON — Town of Peru.

Lapham, railroad tracks in front of station....	298.0	L
Valcour, railroad tracks in front of station....	166.0	L

COUNTY OF COLUMBIA — Town of Claverack.

Claverack, village crossroads 1-3 mile southwest of railroad station	187	L
Claverack creek, floor of bridge over, 1-2 mile southwest of Claverack railroad station....	145	L

Humphreysville, floor of bridge by stone mill..	171	L
Humphreysville, road forks 1-4 mile east of stone mill	196	L
Humphreysville, road junction 1 mile north of, on Humphreysville-Claverack road.......	182	L

COUNTY OF COLUMBIA — Town of Clermont.

Clermont, crossroads at post-office and hotel..	226	L
Clermont, road forks 1 mile west of hotel......	246	L
Clermont, road junction 3-4 mile north of, on stage road to Hudson.....................	229	L
Elizaville, 1 1-2 miles west of, Columbia-Dutchess county line, base of 2-chimney white house, just west of top of bare ridge. (Road south of house is the county line.)..........	345	T
Ellerslie station, Silvernails and Rhinecliff branch of Philadelphia, Reading and New England Railroad	269	L
Nevis, hill 1-3 mile southwest of, summit on Clermont and Red Hook town line.........	326	T
"Nevis," (U. S. G. S. station), bare hill 1 1-2 miles east of Nevis crossroads, just south of road and 1-4 mile west of Roeliff Jansen Kill,	321	T
Roeliff Jansen Kill, water surface under bridge 1-4 mile southwest of Blue Store...........	166	L
Roeliff Jansen Kill, water surface under bridge at Elizaville	224	L
Roundtop Hill, east side of road, 1 mile south of Viewmonte	310	L
Viewmonte, nearly bare hill 3-4 mile south of..	341	T
Viewmonte, Ambrose Rockefeller's house, 1 mile south of road junction in front of......	198	L

COUNTY OF COLUMBIA — Town of Gallatin.

Elizaville and Jackson Corners road, junction 1 1-4 miles east of Elizaville	289	L
Jaskson Corners and Elizaville road, 1 mile northwest of Jackson Corners — highest point in road by watering-trough..........	301	L

"Snyderville," (U. S. G. S. station), high bare hill 1-2 mile southwest of Snyderville, west side of road	666	T

COUNTY OF COLUMBIA — Town of Germantown.

Hover Hill, 1 mile northeast of Germantown, base of yellow cupola house	327	T

COUNTY OF COUMBIA — Town of Greenport.

Greendale, 1 1-4 miles northeast of	385	T
Jones' quarries, 1 mile south of Hudson reservoirs, bare ridge southwest of quarries	418	T
Mt. Merino (U. S. G. S. and U. S. C. & G. S. station), high bare hill 2 miles southwest of Hudson and 3-4 mile from river	543	T
"Olana" F. E. church, base of house	480	T

COUNTY OF COLUMBIA — City of Hudson.

Hudson, Cemetery Hill, north of Hudson reservoirs	375	T

COUNTY OF COLUMBIA — Town of Livingston.

Bell Pond, 1 1-2 miles south of Humphreysville,	222	L
Blue Store, crossroads	186	L
Blue Store Hotel, floor of front porch	190	L
Blue Store, crossroads, 3-4 mile northeast of	213	L
Blue Store and Manorton — road junction midway between	191	L
Blue Store, very round and nearly bare hill 1 mile northeast of	346	T
Blue Store and Burden road — forks midway between	273	T
Blue Hill, north summit wooded	595	T
Blue Hill, between Greendale and Burden, south summit wooded	650	T
Burden, crossroads east of	220	L
Elizaville Hotel, lower board step to post-office	266	L

Elizaville, road junction just north of schoolhouse	282	L
Elizaville and Manorton road, road junction 1-4 mile west of Twin Ponds (north one)	273	L
Livingston (Johnstown), crossroads in village..	198	L
Livingston, road junction 3-4 mile north of, on Hudson and Clermont stage road, north end of road triangle, road leading to east	193	L
Livingston, road junction 1-2 mile east of crossroads at "Johnstown"	292	L
Livingston, road junction 1 1-2 miles east of crossroads and just north of Pine Hill	344	L
Manorton, south end of road triangle at forks southwest of church	245	L
Manorton, floor of bridge over brook 1-2 mile south of church	217	L
Mt. Tom (U. S. G. S. station), bare hill 1 mile northwest of Burden crossroads	519	T
Twin Ponds — north one	265	L

COUNTY OF COLUMBIA — Town of Taghkanic.

Pine Hill (U. S. G. S. station), summit just east of Livingston-Taghkanic town line, hill halfway between West Taghkanic and Johnstown, entirely bare	617	T
Schoolhouse in extreme southwest corner of town and in northwest corner of road junction	496	T
West Taghkanic and Livingston road; junction 3 miles west of West Taghkanic; also, 1-2 mile east of Pine Hill	460	L

COUNTY OF DUTCHESS — Town of Clinton.

Beaman Corners, 1 mile west of Bull Head, road junction at blacksmith shop	424	L
Beaman Corners, crossroads 1-2 mile west of..	406	L
Beaman Corners, forks south of	377	L
Bull Head, wooded Hill 1-2 mile north of	702	T

Clinton Corners, tracks in front of railroad station.	288	L
Clinton Corners and Clinton Hollow road, 2 miles from Clinton Corners, at forks 1-2 mile southeast from and below schoolhouse.	346	L
Clinton Hollow, dam near bridge.	299	L
Clinton Hollow, road junction 1-3 mile east of flour mill, at road leading to north.	442	L
Clinton Hollow and Schultzville road, junction midway, at road leading to east.	426	L
Clinton Hollow, road junction east of flour mill at long straight road leading to south.	325	L
Clinton Hollow, road junction 1 mile southeast of — the branch road leads to Salt Point. . . .	494	L
Conover Hill, bare hill 1 mile southwest of Clinton Corners railroad station.	523	T
Crum Elbow creek, road junction just east of small bridge over, in extreme northwestern part of town.	427	L
Hudson River Slate Company quarries, forks of road northwest of.	596	L
Lent — Orchard Hill farm — prominent wooded hill 1-2 mile east of.	731	T
Long Pond, wooded hill 3-4 mile northwest of. .	750	T
Pleasant Plains, in front of store and post-office.	287	L
Pleasant Plains, 1-2 mile north of, at junction of private road leading to west.	282	L
Pleasant Plains, high wooded hill 1-2 mile south of	619	T
"Pleasant View," midway between Clinton Corners and Schultzville, 200 yards west of road, base of red roofed yellow house.	549	T
Poughkeepsie and Eastern railroad, first road crossing 1-3 mile south of Clinton Corners. .	277	L
Poughkeepsie and Eastern railroad, second road crossing 1 mile south of Clinton Corners. . . .	278	L

Poughkeepsie and Eastern railroad, third road crossing (near second) south of Clinton Corners.	277	L
Poughkeepsie and Eastern railroad, first road crossing 1-4 mile north of Clinton Corners. .	292	L
Schultz Mountain, high wooded hill in northwest part of the town, southwest of Long Pond.	780	T
Schultzville, crossroads by post-office.	375	L
Schultzville, road junction 3-4 mile north of. . . .	358	L
Schultzville, crossroads 1 mile east of.	401	L
Schultzville, road junction 1-2 mile south of. . .	467	L
Traver Hill, U. S. G. S. station, northwest part of town, 3-4 mile northwest of Schultz Mountain.	693	T

COUNTY OF DUTCHESS — Town of Hyde Park.

Crum Elbow, crossroads south of, junction of Quaker lane and roads leading to Hyde Park and Salt Point	329	L
East Park, crossroads	233	L
East Park, forks 1-2 mile west of, by saw-mill,	208	L
East Park, forks 1-4 mile east of, by schoolhouse	233	L
East Park, on road east from, 1 1-4 miles, at private road leading to south.	297	L
East Park, road junction 1 1-2 miles east of, and 1 mile west from Quaker Lane.	249	L
Hyde Park, N. Y. C. & H. R. R. R. tracks in front of railroad station	10	L
Hyde Park, road junction northeast of, and near railroad station	39	L
Hyde Park, forks half way from station to village	114	L
Hyde Park, crossroads at Baptist church.	178	L
Hyde Park, junction of Albany and Main streets	187	L

Hyde Park, junction of Albany and Albertson streets	184	L
Hyde Park, junction of Albany and Williams streets	184	L
Hyde Park, road junction 1-2 mile south of village crossroads (Albany and Market streets),	186	L
Lloyd Hill (U. S. G. S. & G. S. station), east part of town, 3 1-2 miles northeast of Hyde Park.	606	T
Lloyd Hill, base of red roofed white house 1-2 mile southeast of, north side of and at highest point in road	465	T
Lloyd Hill, Crum Elbow and Pleasant Plains road, northeast of, just north of schoolhouse, at junction of road leading to east	334	L
Pleasant Plains and Wurtemburg road, junction midway just west of Crum Elbow creek, at road leading up steep hill to west	299	L
Staatsburgh, New York Central and Hudson river railroad tracks in front of railroad station	30	L
Staatsburgh, N. Y. C. & H. R. R. R., under-grade crossing, 1 mile north of, floor of road bridge opposite residence of Mr. Dinsmore	48	L
Staatsburgh, N. Y. C. & H. R. R. R., under-grade crossing, 1-2 mile north of, floor of road bridge opposite large white house on hill west	54	L
Staatsburgh, N. Y. C. & H. R. R. R., first under-grade crossing, 1-4 mile north of, floor of road bridge.	51	L
Staatsburgh, N. Y. C. & H. R. R. R., over-grade crossing at private road 1 mile south of, road under bridge	7	L

COUNTY OF DUTCHESS — Town of Milan.

Boice Hill (U. S. G. S. and U. S. C. & G. S. station), southwest corner of town, high bare hill 1-2 mile north of Enterprise post-office and almost on Milan-Rhinebeck town line.	749	T

"Cherry Grove," 2 miles southwest of Lafayetteville, forks south of (schoolhouse just east of forks)	662	L
Cokertown and Elizaville road, highest point on road, 1-2 mile north of cupola schoolhouse,	425	L
Cokertown, forks 1-2 mile east of, just southwest of spring under tree	352	L
Cokertown (U. S. G. S. station) west side of road 1 1-2 miles southeast of Crokertown; four apple trees on small flat summit	725	T
Cokertown and Jackson Corners road, 1 1-2 miles east of Cokertown, on south side of Turkey Hill, base of white house, north side of road (red barns back of)	665	T
Elizaville and Cokertown road, road junction 3-4 mile south of Ellersville railroad station, north end of road triangle	291	L
Jackscn Corners, tracks in front of railroad station, Silvernails and Rhinecliff branch of Philadelphia and Reading and New England railroad	328	L
Jackson Corners, in front of Cole's store and post-office	300	L
Jackson Corners, road junction 1-4 mile east of Cole's store, at road leading to railroad station	359	L
Jackson Corners, road forks on telegraph pole 1-2 mile south of railroad station	349	L
Jackson Corners, road junction 1 mile south of, at road leading to east by barn in southeastern corner	400	L
Jackson Corners, rocky bare hill 3-4 miles southwest of	731	T
Jackson Corners, high nearly bare hill 1 1-2 miles southwest of, 1-2 mile northeast of schoolhouse No. 8	886	T
Jackson Corners, high sharp wooded hill 2 miles south of, west of telegraph road on way to Lafayetteville	875	T

Lafayetteville, crossroads	667	L
Lafayetteville, road junction 3-4 mile west of, also opposite gate to private road leading to north	551	L
Lafayetteville, road junction 2 miles north of, east of schoolhouse	520	L
Lafayetteville, road junction 2 miles north of, west of schoolhouse	535	L
Lafayetteville, prominent wooded hill 1 mile northwest of, very steep near summit......	848	L
Turkey Hill (U. S. G. S. station), 1 3-4 miles northeast of Cokertown and 1-2 mile north of road to Jackson Corners; highest hill in vicinity; bare	783	T

COUNTY OF DUTCHESS — Town of Pleasant Valley.

Barnes Hill (U. S. G. S. station), northwest part of town, bare hill west of and near road....	554	L
Dennis Hill (U. S. G. S. station), high bare hill in northwest part of town, just south of road from Hyde Park to Salt Pond.............	563	T
Pleasant Valley, Poughkeepsie and Eastern railroad tracks in front of railroad station..	199	L
Poughkeepsie and Eastern railroad, road crossing 1-2 mile south of Pleasant Valley......	212	L
Poughkeepsie and Eastern railroad, first road crossing 1-2 mile north of Pleasant Valley..	227	L
Poughkeepsie and Eastern railroad, second road crossing 2 1-2 miles north of Pleasant Valley	230	L
Poughkeepsie and Eastern railroad, third road crossing north of Pleasant Valley, 1 mile south of crossing of P., R. & N. E. R. R......	247	L
Poughkeepsie and Eastern railroad, first road crossing north of Salt Pond, road to east..	249	L
Poughkeepsie and Eastern railroad, second road crossing north of Salt Pond, road to Clinton Corners	260	L
"Quality Place," 1 1-2 miles southeast of Salt Point, forks east of	267	L

Salt Point, Poughkeepsie and Eastern railroad tracks in front of railroad station.........	249	L
Salt Point, floor of red iron bridge over Wappinger creek, 1-2 mile east of Salt Point	238	L
Salt Point, forks 1-2 mile east of, just west of P. R. & N. E. R. R. crossing	241	L
Van Wagner station (P. & E. R. R.), road junction 2 miles northeast of and 1 1-2 miles west of Pleasant Valley, just south of junction of Pleasant Valley and Salt Point roads......	296	L
Washington Hollow, forks by old schoolhouse 1 mile southwest of	352	L
Washington Hollow and Pleasant Valley road, 1 mile southwest from Washington Hollow, at forks 1-4 mile south of old schoolhouse...	368	L

COUNTY OF DUTCHESS — Town of Poughkeepsie.

Van Wagner flag station, Poughkeepsie and Eastern railroad, rails in front of	242	L
Van Wagner station, road junction 1-2 mile north of	265	L

COUNTY OF DUTCHESS — Town of Red Hook.

Barrytown, N. Y. C. & H. R. R. R. tracks in front of railroad station	15	L
Barrytown "Corners," 1 mile from Barrytown railroad station	173	L
Cokertown, road junction just west of.......	344	L
Madalin, crossroads at hotels................	152	L
Madalin, crossroads 1-2 mile east of..........	149	L
Madalin (U. S. G. S. station), bare hill 1 1-2 miles east of Madalin, on south side of road to Upper Red Hook, highest hill within 3 miles	409	T
Red Hook, tracks in front of railroad station, Silvernails and Rhinecliff branch of Philadelphia, Reading and New England railroad,	217	L

Red Hook, village crossroads by hotels.......	217	L
Red Hook, road junction 1 mile northeast of..	232	L
Red Hook, road junction 1-2 mile west of......	207	L
Red Hook and Barrytown road, highest point on, half way between	280	L
Red Hook, crossroads, Fish and Depot streets,	215	L
Saw Kill, water surface under bridge half way Red Hook and Upper Red Hook...........	203	L
Spring Lake, tracks in front of railroad station, Silvernails and Rhinecliff branch of Philadelphia, Reading and New England railroad..	254	L
Spring Lake, hill directly south of railroad station	502	T
Stony creek, 1 1-4 miles northeast of Madalin, floor of bridge over — bridge just east of mill,	171	L
St. Stephen's College, Anandale, long, bare hill 1-2 mile northeast of	305	T
Tivoli, N. Y. C. & H. R. R. R. tracks in front of railroad station	10	L
Tivoli, road junction 1-2 mile east of, at river road, from north	148	L
Upper Red Hook, in road east of hotel.......	238	L
Upper Red Hook, road junction 3-4 mile southwest of	241	L
Upper Red Hook and Red Hook road, junction 1 1-4 miles south of Upper Red Hook	226	L
Upper Red Hook, base of yellow house on top of ridge 1 1-2 miles northeast of, house north side of road and 100 yards east of road junction	359	T
Upper Red Hook, wooded hill 1 mile northeast of, steep on northwest side	485	T

COUNTY OF DUTCHESS — Town of Rhinebeck.

Berger Hill (U. S. G. S. station) U. S., C. & G. S. station of 1857, know as "Traver;" on Rhinebeck and Wurtemberg road, midway; west side of road.......................	562	L

Crum Elbow creek, near headwaters; road junction between small bridges very near on either side	518	L
"Ellerslie," Levi P. Morton's, base of house..	190	T
Mount Rutzger, 2 1-2 miles north of Rhinebeck, roof of tower	390	T
Rhinebeck village, crossroads in front of Rhinebeck hotel	203	L
Rhinebeck, in front of Rhinebeck inn........	201	L
Rhinebeck, road forks east of village by cider mill	194	L
Rhinebeck and Lafayetteville road, junction 1 1-4 miles east of Rhinebeck, at road leading to Wurtemberg	215	L
Rhinebeck and Wurtemburg road, 1 1-2 miles east of Rhinebeck, road junction 65 feet above Landsman creek, house and greenhouses in southwest corner	272	L
Rhinecliff, N. Y. C. & H. R. R. R. tracks in front of station	12	L
Rhinecliff, on stage road to Rhinebeck, 1 mile from railroad station, where road bends to the east, at junction of short road to west..	97	L
Rhinecliff and Rhinebeck stage road, just east of schoolhouse at junction of river road leading to north	152	L
Wurtemburg, road junction 1 mile north of church, at road leading to east........	363	L
Wurtemburg, first road junction south of, at road to east	389	L
Wurtemburg, second road junction south of, at road to west	352	L
Wurtemburg, third and fourth road junctions south of, midway between roads to west and east	316	L

COUNTY OF DUTCHESS — Town of Stanford.

Bear Market Four Corners, road junction 3-4 miles west of	458	L
Bear Market Four Corners, road junction 1 1-4 miles west of, at road leading south to Clinton Corners	560	L
Bear Market Four Corners, forks 1 1-2 miles west of, at roads leading to Schultzville and Lafayetteville	635	L
Bridge Hill (U. S. G. S. station), extreme northwest part of town, 1 mile northeast of schoolhouse at crossroads, high bare hill west of higher ridge	883	T
Bull Head, crossroads 1 1-2 miles northeast of, schoolhouse in northeast corner; elevation at crossroads	555	L
Poughkeepsie and Eastern railroad, first road crossing south of Willow Brook, 1-3 mile east of Upton Pond House................	354	L
Prospect Hill, just east of Stanford-Clinton town line, 1-3 mile north of schoolhouse, line of tall trees on summit	723	L
Upton Pond House, base of house in front....	355	T
Willow Brook, Poughkeepsie and Eastern railroad tracks in front of railroad station....	351	L
Willow Brook, road junction 1-2 mile north of, at road leading to Stanfordville............	352	L
Willow Brook, forks 1-2 mile north of, at road to Bear Market Four Corners	363	L
Willow Brook, forks 3-4 mile north of, road to north nearly level, road to west up steep hill	371	L

COUNTY OF ERIE — Town of Amherst.

Erie canal, three miles north of Getzville....	570	L
Getzville, track at station..................	583	L
Getzville, three corners 2 miles north of......	578	L

Getzville, four corners 1-2 mile north of......	577	L
Getzville, three corners 1 mile south of railroad,	582	L
Getzville, first road crossing (1 mile) west of station	576	L
Getzville, second road crossing (1 1-2 miles) west of station	576	L
Getzville, third road crossing (3 miles) west of station	575	L
Getzville, first road crossing (1-2 mile) east of station	583	L

COUNTY OF ERIE — City of Buffalo.

Buffalo, surface of water, Lake Erie..........	573	L
Buffalo, railroad tracks at Exchange street station	582	L
Buffalo, Bidwell place, north end............	631	L
Buffalo, Delavan avenue and Williamsville road	638	L
Buffalo, Delaware avenue and Utica street....	664	L
Buffalo, Elk and Seneca streets.............	584	L
Buffalo, Filmore Parkway and Batavia street..	602	L
Buffalo, Genesee avenue and Jefferson street..	625	L
Buffalo, Humboldt avenue and Main street..	641	L
Buffalo, Main and Bird streets...............	646	L
Buffalo, Soldiers place (west side)............	619	L
Buffalo, Tonawanda and Bird streets........	590	L

COUNTY OF ERIE — Town of East Hamburgh.

Webster Corners, three corners 1 1-2 miles north of, road east...........................	715	L
Webster Corners, three corners 1 mile north of,	758	L
Webster Corners, three corners 1 1-2 miles west of	725	L
Webster Corners, four corners 3-4 miles south of	719	L
Windom, three corners 1 mile south of........	749	L

COUNTY OF ERIE — Town of Hamburgh.

Bay View, three corners 3-4 mile south of Bay View Hotel	585	L
Big Tree, four corners at hotel	664	L
Big Tree, three corners 1-2 mile west of	717	L
Big Tree, four corners 1-2 mile west of station	685	L
Lake Erie, surface of water	573	L

COUNTY OF ERIE — Town of Tonawanda.

Tonawanda, grade crossing Batavia branch of N. Y. C. & H. R. R. R. and N. Y., L. E. & W. R. R	580	L
Tonawanda, track N. Y., L. E. & W. R. R. crossing Ellicott creek	582	L

COUNTY OF ERIE — Town of West Seneca.

Ebenezer, three corners of plank-road at	635	L
Ebenezer, crest of hill, four corners at	633	L
Ebenezer, three corners on plank-road 1 mile west of	619	L
Ebenezer, water level of Cazenovia creek at plank-road crossing 1 1-4 miles west of	606	L
Reserve, roadway at toll-house	632	L
Reserve, three corners 3-4 mile northwest of	618	L
Reserve, three corners road west at	640	L
Reserve, three corners at road west 3-4 miles southeast of	707	L

COUNTY OF ESSEX — Town of Chesterfield.

Auger lake, water level	549.00	L
Auger lake, house between forks of Keeseville-Elizabethtown and Keeseville-Willsboro roads, two miles south of Interlaken House,	782.00	L
Auger lake, road crossing half mile east of Interlaken House	556.00	L
Auger Lake brook, floor of iron bridge, 2 miles south of Keeseville, on Elizabethtown road	483.80	L

Baldface mountain	2,220.00	T
Butternut pond	679.00	T
Fordway mountain	1,425.00	T
Interlaken House, Auger lake	617.00	T
Interlaken Hotel, crossroads 1-2 mile east....	556.30	L
Keeseville, Roman Catholic church, south of river, top of top step in front of door (main entrance)	509.00	L
Keeseville, Elizabethtown and Willsboro roads, three forks of	780.30	L
Lake Champlain, water level	101.10	L
Long pond summit, between Long pond and Auger lake, on Keeseville-Willsboro road..	993.00	L
Macyo House, three corners road, 3 miles south of Keeseville, on Keeseville-Elizabethtown road	677.50	L
Maguire's house, north slope of Poke-a-Moonshine	1,114.00	T
Montreal or Bluff mountain	2,956.00	T
Mt. Bigelow (Coast Survey Signal)	1,658.00	T
Mt. Bigelow (west ledge)	1,651.00	T
Mt. Poke-a-Moonshine (Colvin signal)........	2,162.00	T
Port Douglas railroad station, tracks	204.00	L
Prospect Hill, Burton signal	915.00	T
Schoolhouse, red brick, on Keeseville-Willsboro road	846.00	L
Schoolhouse, red brick, small pond 1-2 mile south of	831.00	L

COUNTY OF ESSEX — Town of Elizabethtown.

Bald peak	3,007	T
Cobble hill	1,792	T
Deer mountain	2,177	T
Elizabethtown, Colvin's bench-mark on door-sill, main entrance to Mansion house.......	599.5	L
Elizabethtown, Colvin's bench-mark north of Keene road near gristmill, 1-2 mile west of,	698.4	L

Elizabethtown-Keene road, Colvin's bench-mark on rock east end of bridge over Boquet river at Jackson Fork	759.1	L
Elizabethtown-Keene road, Colvin's bench-mark on small rock south side of road 100 feet west of John Murphy's	1,261.7	L
Elizabethtown-Keene road, Colvin's bench-mark on rock north side of road 400 feet east of James McDougal's house	1,482.3	L
Elizabethtown-Westport road, Colvin's bench-mark on rock north side of road east end of Raven pass	708.1	L
Elizabethtown-Westport road, Colvin's bench-mark on granite boulder, west end of Raven pass	722.5	L
Holcomb mountain	2,326	T
Hurricane mountain	3,689	T
Iron mountain	1,960	T
Lincoln pond	1,050	T
Lincoln pond, crossroads 2 miles north of	1,170	T
Little Raven mountain	1,400	T
Noble mountain	2,900	T
Oak hill	1,730	T
Raven mountain (C. S. triangulation station)	1,967	T
Split Rock mountain (highest point)	1,960	T
Wood's hill	1,240	T

COUNTY OF ESSEX — Town of Essex.

Boquet mountain, summit	1,225	T
Boquet mountain, west, east end	1,245	T
Boquet mountain, west, west end	1,225	T
Boquet village, summit of road 1-2 mile west of,	340	T
Essex railroad station, tracks	277	L
Essex, First Baptist Church	619	T
Essex village, stone church 1-2 mile north of	165	T
John Lott's house, 1-2 mile southwest Whipple mountain	381	T

Lake Champlain, water level	101	L
Schoolhouse, white, on road between Whallensburgh and Split Rock light	290	T
Split Rock light, foot of tower	170	T
Summit between Essex and Essex Station Four Corners	360	T
Whallensburgh railroad station, tracks	273	L
Whipple mountain, summit	980	T

COUNTY OF ESSEX — Town of Jay.

Ausable Forks, foot of tower, Graves' house	562	T
Bald mountain	2,139	T
Bassett mountain	1,954	T
Clark mountain	1,577	T
Clements mountain (east end)	2,540	T
Clements mountain (west end)	2,555	T
Ellis mountain	1,856	T
Hamlin mountain (iron bolt marking Wilmington-Jay town line)	2,122	T
Haystack mountain	1,338	T
Jay, floor of bridge over Ausable river	644	L & T
Jay, red brick church, white steeple	691	T
Mt. Ebenezer (east top)	1,768	T
Pat Madden's house, 5 miles southeast of upper Jay, on Jay-Elizabethtown road	1,763	T
Rattlesnake Knob (on Jay-Wilmington town line)	1,855	T
Stickney bridge, over Ausable river	585	L & T
Upper Jay, white, frame church, west of road, west bank of Ausable river	676	T
Wainright mountain	1,633	T
Willey House, old house in flat 1 mile northeast of East Hill, Keene valley	2,225	T

COUNTY OF ESSEX — Town of Keene.

Allen mountain	4,257	T
Ausable lake (lower)	1,959	L
Ausable lake (upper)	1,993	L

Ausable river, Colvin B. M. on bridge stringer over, at forks of road 3 miles below Keene Valley post-office	982.5	L
Ausable river, east branch, crossing near Beedes	1,089	L
Ausable river, east branch, at Shaw's bridge	972	L
Ausable river, east branch, at bridge at Keene village	818	L
Ausable river, west branch, at North Elba bridge	1,676	L
Avalanche lake	2,863	L
Basin mountain	4,823	T
Baxter mountain	2,400	T
Bear Den mountain	3,423	T
Big Slide mountain	4,255	T
Cascade mountain	4,092	T
Cascade lake (upper)	2,039	L
Cascade lake (lower)	2,032	L
Cascade lake (lower), Colvin B. M on rock west side of outlet	2,035.7	L
Chapel pond	1,602	L
Golden lake	2,764	L
Dial mountain	4,023	T
Grant mountain, triangulation station	4,622	T
Gothic mountain	4,738	T
Gill brook, crossing at road to Ausable lake	1,465	L
Hopkins peak	3,175	T
Indian Face mountain	2,730	T
Keene valley, Colvin, B. M., north side Elizabethtown road in pass between Ausable and Boquet waters	1,709.7	L
Keene valley, Colvin, B. M., in Elizabethtown road on flat rock in front of log schoolhouse on Partridge hill	1,664.7	L
Keene valley, Colvin B. M., on rock in forks of road to Keene valley and Keene village in front of Holt's house	995.7	L

Keene valley, Colvin B. M. in foundation of piazza of Dibble's house	1,033.9	L
Keene valley, Colvin B. M. on flat rock 200 feet north of Beede's house (old place)	1,294.2	L
Keene valley, Colvin B. M. on rock near Beede's new house	1,359.3	L
Keene valley, Colvin B. M. on rock over Johns brook	1,016.6	L
Keene valley	854	L
Knob Lock mountain	3,184	T
Lake Champlain, mean level	101	L
Marcy and Cold Spring trails, junction of	2,028	L
Moose mountain	2,766	T
Mount Colden, triangulation station	4,713	T
Mount Colvin	4,074	T
Mount Haystack, triangulation station	4,918	T
Mount Marcy, triangulation station	5,344	L
Mount Marcy, hump on south side of	4,998	L
Mount Marcy, 1 mile south of Colvin B. M. at junction of trails to Skylight, Marcy and Lake	4,349	L
Mount Redfield	4,600	T
Mount Skylight	4,920	T
Nippletop mountain	4,620	T
Noonmark mountain	3,552	T
Pitchoff mountain, north of Cascade lakes	3,520	T
Porter mountain	4,070	T
Potash mountain	2,820	T
Red rock on Oak ridge	2,490	T
Rocky Peak ridge, highest point	4,375	T
Rooster Comb mountain	2,785	T
Round mountain	3,145	T
Saddleback mountain	4,530	T
Soda mountain	2,697	T
Spread Eagle mountain	2,860	T
Table Top mountain	4,440	T

Tear of the Clouds lake	4,321	L
Tripod mountain	3,340	T
Wolf Jaws mountain	4,225	T

COUNTY OF ESSEX — Town of Lewis.

Deerfield mountain	2,080	T
Francis Dupair's house, Keeseville-Elizabethtown, south of Poke-a-Moonshine	860	T
Hale Hill	1,640	T
Lewis Center, schoolhouse on Jay road 2 1-2 miles northwest of	1,156	T
Lime Kiln mountain (east point)	2,925	T
Lime Kiln mountain (west point)	2,913	T
Marciel Phillippe's house, 1-2 mile south of Poke-a-Moonshine	850	T
Methodist Church, crossroads, Keeseville-Elizabethtown and Kellybrook-Reber roads, 4 miles east of north of Lewis Center	638	T
Mt. Fay	2,312	T
Old kilns, 3 1-2 miles northwest Lewis Center,	1,655	T
Rattlesnake mountain	1,328	T
Saddleback mountain	3,623	T
Severance's house, 1 mile north Tower's forge	562	T
Thos. Cross' house at bridge across north branch Boquet river, Keeseville-Elizabethtown road	640	T

COUNTY OF ESSEX — Town of Moriah.

Bald Knob	2,055	T
Barton hill	1,889	T
Belfry hill	1,892	T
Blueberry hill	2,323	T
Broughton ledge, highest point	1,963	T
Harris hill, highest point	2,190	T
Mineville, railroad crossing near post-office	1,202	L
Mount Tom	1,620	T
Port Henry, rail in front of station	120	L

COUNTY OF ESSEX — Town of North Elba.

Brewster triangulation station (Colvin)	1,981	T
Buck island	2,188	T
Chubb river bridge, Colvin B. M. on flat rock south side of road and 300 feet west of bridge,	1,742.9	L
Church, one mile south of North Elba post-office	1,810	T
Clear lake	2,155	L
Cobble hill	2,330	T
Freeman's Home, Colvin B. M. on rock in front of schoolhouse	2,086	L
Grand View House, Lake Placid	1,960	T
Lake Placid, water level	1,864	L
McIntyre mountain	5,112	T
Mirror lake, water level	1,860	L
Mount Jo	2,870	T
North Elba bridge	1,686	L
Pulpit mountain	2,858	T
Stevens House, Lake Placid	1,964	T

COUNTY OF ESSEX — Town of North Hudson.

Beech ridge, 1 mile north of Elk lake	2,532	T
Boreas Pass, between Ausable lakes and Boreas ponds	2,019	L
Boreas pond	1,973	L
Buck mountain	2,255	T
Camel's Hump	2,785	T
Cheney Cobble mountain	3,673	T
Clear pond	1,911	L
Dix mountain, triangulation station	4,842	T
Elk lake pass, railroad notch between Ausable and Elk lakes	2,650	L
McComb triangulation station	4,325	T
Moose mountain	2,756	T
Niagara mountain	3,000	T
Old Far mountain	2,325	T
Saunders mountain	2,003	T

COUNTY OF ESSEX — Town of St. Armand.

Eagles Iris	2,656	T
Lake Placid, water level	1,864	L
Slide mountain	3,909	T

COUNTY OF ESSEX — Town of Ticonderoga.

Academy, top of rail in front of station......	274	L
Delano, first road crossing on the Ticonderoga branch of the D. & H. C. Co. R. R. west of..	155	L
Lake George, rail at mill at outlet of.........	327	L
Lake George, bridge north of dam at outlet of,	329	L

COUNTY OF ESSEX — Town of Westport.

Campbell mountain highest point............	1,900	T
Coon mountain	1,015	T
Payne hill, western top......................	850	T
Wadham's Mills, rail in front of station, D. & H. C. Co. R. R............................	301.8	L
Westport, rail in front of station, D. & H. C. Co. R. R...............................	271.3	L
Westport, Colvin's bench-mark on stone water-table, northwest corner Academy, Westport,	166	L
Westport-Elizabethtown road Colvin's bench-mark top of large bowlder in front of school-house 4 miles west of Westport...........	588	L

COUNTY OF ESSEX — Town of Willsboro.

Flackville, (Reber P. O.), M. E. church........	335	T
Lake Champlain, water level..................	101	L
Long pond, water level......................	566	L
Long pond, top of large rock marked "Scotch Oil," between Long and Warm ponds, three corners on Keeseville and Willsboro road...	601	L
Rattlesnake mountain, north end.............	1,300	T
Rattlesnake mountain, south end............	1,265	T
Sugar Loaf mountain, summit...............	1,455	T

Warm pond, water level	566	L
Willsboro railroad station, tracks	231	L
Willsboro, point	215	T

COUNTY OF ESSEX — Town of Wilmington.

Hamlin mountain, iron bolt marking Wilmington-Jay town line	1,855	T
Marble mountain	2,725	T
Rattlesnake knob, on Wilmington-Jay town line	1,855	T
Sentinel (peak)	3,858	T
Whiteface	4,872	L
Wilmington, red brick church, white steeple, east of river, large bowlder west of church	1,027	L
Wilmington, floor of bridge over east branch of Ausable river	982	L
Wilmington, "Restaurant" 2 miles south of, on upper Jay road	1,085	L

COUNTY OF FRANKLIN — Town of Franklin.

Franklin Falls, northeast corner of Franklin House	1,426	L
French's Hotel	1,665	L

COUNTY OF GREENE — Town of Athens.

West of Athens, West Shore railroad, tracks in front of railroad station	133	L
West Shore railroad, first crossing south of West Athens	128	L

COUNTY OF GREENE — Town of Cairo.

Acra, smooth hill 3-4 mile east of village	608	T
Cairo Round Top, high wooded hill	1,420	T
South Durham, smooth hill 1 mile southeast of village	930	T

COUNTY OF GREENE — Town of Catskill.

Cairo Junction, Catskill Mountain railway and Cairo railroad	347	L
Catskill village, Catskill Mountain railway and Cairo railroad, tracks in front of station....	16	L
Catskill village, Catskill Mountain railway and Cairo railroad, West Shore station	31	L
Catskill village, crossroads Main and Bridge streets	36	L
Glenwood House, base of, halfway between Catskill and Palenville	210	T
Grant House, road in front of house, at base of front steps	180	T
Grant House, base of windows in main cupola,	237	T
High Falls, wooded hill 1-2 mile east of covered wooden bridge	484	T
Lawrenceville, Catskill Mountain railway....	385	L
Leeds tollgate, Catskill Mountain railway and Cairo railroad, 1 mile west of Leeds village..	200	L
Mountain House station, Catskill Mountain railway	517	L
Overbaugh hill, 2 1-2 miles east of Lawrenceville station and 1-4 mile south of schoolhouse, bare hill	586	T
Otis Junction, Catskill Mountain railway.....	551	L
Palenville, Catskill Mountain railway........	515	L
Prospect Park Hotel, Catskill village, main porch in front	137	T
Summit Hill House, 1 mile north of village, floor of front porch	195	L
Summit Hill House, roads forks just north of,	156	L
Timmerman Hill House, high wooded hill 1 mile south of Glenwood House	598	T
Vedder Hill, high wooded ridge 1 1-2 miles southwest of Leeds	615	T
West Shore railroad, road crossing opposite Summit Hill House	125	L

West Shore railroad, first underhead crossing south of Catskill, floor of bridge...........	129	L
West Shore railroad, second underhead crossing south of Catskill, floor of bridge........	134	L
West Shore railroad, road crossing 3 miles south of Catskill, 1-4 mile south of brick schoolhouse	109	L
West Shore railroad, first road crossing (1 mile) north of West Camp station—leads to Smith landing	120	L
West Shore railroad, second road crossing north of West Camp station, by schoolhouse,	111	L
West Shore railroad, third road crossing north of West Camp station, leads to icehouses....	108	L
West Shore railroad, fourth road crossing (above grade) north of West Camp station, road under bridge	91	L

COUNTY OF GREENE — Town of Coxsackie.

Coxsackie, West Shore railroad tracks at station	139	L

COUNTY OF GREENE — Town of Durham.

East Durham, hill south of road, 1-3 mile southwest of village	946	T
Pisgah mountain	2,885	T

COUNTY OF GREENE — Town of Hunter.

Haines Corners, Stony Clove and Catskill Mountain railroad station, tracks in front of,	1,920	L
High peak	3,660	T
Hunter mountain	4,025	T
Indian Head (hill)	3,585	T
Kaaterskill station, S. C. & C. M. R. R. tracks..	2,145	L
Kaaterskill Junction, S. C. & C. M. R. R. station, tracks	1,700	L
Laurel House, S. C. & C. M. R. R. station, tracks,	2,067	L
Plateau mountain	3,855	T

Plaaterskill mountain	3,135	T
Roundtop	3,470	T
Star Rock	2,515	T
Star Rock, hill 1-2 mile east of...............	3,120	T
Sugar Loaf	3,782	T
Stony Clove Gap (highest point), S. C. & C. M. R. R.	2,071	L
Tannersville, S. C. & C. M. R. R. station tracks,	1,862	L
Twin mountain, west peak	3,647	T
Twin mountain, east peak	3,476	T

COUNTY OF GREENE — Town of Jewett.

Black Dome, a hill	3,990	T
Black Head, a hill	3,937	T
Hunter, a hill west of road, from East Jewett to,	3,166	T
Parker mountain	3,205	T
Round hill, 1 1-2 miles south of Hensonville...	2,529	T
Stoppel point, a hill	3,425	T
Thomas Cole, a hill	3,935	T

COUNTY OF GREENE — Town of Windham.

Acra point	3,085	T
Burnt knob, on town line, 3.3 miles southeast of East Windham	3,160	T
East Windham, hill 1-2 mile southeast of hotel,	2,385	T
Ginseng mountain, on town line 2 miles northwest of East Windham	3,790	T
Hayden mountain, on town line 3 miles northwest of East Windham	2,930	T
Union Society, Elm ridge, 1 mile east of village,	2,475	T
Windham, high peak	3,505	T
Zoar mountain, on town line 1-2 mile northwest of East Windham	2,690	T

COUNTY OF GREENE — Town of Westerlo.

Lamb's Corner, hill 1-4 mile northeast of village	1,175	T
South Westerlo, hill 1 1-2 miles northwest of village	1,245	T

COUNTY OF HAMILTON — Town of Morehouse.

Jones' brook, trail crossing from Honnedaga lake to West Canada creek	2,063	L
West Canada creek, top of dam lower Stillwater	2,096	L
West Canada creek, top of large bowlder 20 feet from north end of dam at lower Stillwater, and 20 feet south of road	2,095	L

COUNTY OF HERKIMER — Town of Wilmurt.

Bisby lake; surface of water	2,024	L
Bisby lodge	2,038	L
Cannachagala lake, top of dam	2,151	L
Combs lake, surface of water	1,890	L
Combs Springhole Camp	1,681	L
Combs, Stillwater, south branch of Moose river	1,586	L
Fulton Chain, top of rail in front of railroad station at	1,713	L
Fulton Chain, dam at Old Forge, top of masonry spillway	1,701	L
Honnedaga lake, surface of water	2,184	L
Little Moose lake, surface of water	1,782	L
Moose river bridge, on road between Fulton Chain station and Old Forge, top of masonry, east pier	1,694	L
North lake, top of dam at gate-house	1,823	L
Panther lake, surface of water	1,824	L
South lake, high water	2,011	L
Sylvan pond, first surface of water	2,039	L
Sylvan pond, second surface of water	2,043	L

COUNTY OF JEFFERSON — Town of Adams.

Adams railroad station	597	L
Adams, road crossing 2 miles north of	616	L
Adams, junction of Church and Wright streets,	625	L
Adams, road junction 1 1-2 miles east of, at east bank of Sandy creek near schoolhouse No. 14,	633	L

Adams Center railroad station	610	L
Adams Center, railroad underhead crossing 3-4 mile north of	575	L
Adams Center, railroad underhead crossing 1 1-4 miles north of	554	L

COUNTY OF JEFFERSON — Town of Brownville.

Black river, bridge over, on road from Brownville to Hounsfield	311	L
Brownville railroad station	326	L
Brownville, railroad crossing 3 miles west of, near house of M. Reeves	327	L
Dexter, branch railroad junction of, with Cape Vincent, branch railroad, near highway, between Dexter and Brownville	322	L
Glen Park suspension bridge................	359	L
Limerick railroad station	324	L
Limerick, railroad crossing 2 miles west of, near cheese factory	316	L
Limerick, railroad crossing 3-4 mile west of, near house of R. Moffatt	327	L
Remington paper mill, dam at	349	L

COUNTY OF JEFFERSON — Town of Cape Vincent.

Cape Vincent railroad station, tracks	253	L
Cape Vincent, railroad crossing 2 miles east of, near N. Rapo's house	288	L
Cape Vincent, railroad crossing 2 1-2 miles east of, near G. White's house	280	L
Cape Vincent, road junction 1 1-2 miles south of, on Pleasant Valley road, near S. Wilson's house	296	L
Cape Vincent, crossroads 1 3-4 miles south of, on Pleasant valley road, just north of Mud creek	314	L
River View, platform of scales in front of hotel,	272	L
River View, road junction 1-2 mile southwest of,	272	L
Rosiere railroad station	306	L

Rosiere, road junction 1 3-4 miles north of, near house of C. Voutrain	301	L
Rosiere, railroad crossing 3-4 mile east of....	330	L
Rosiere, road junction 1 3-4 miles north of, near L. Aubertime's house	288	L
Schoolhouse No. 4, road junction at..........	299	L
Schoolhouse No. 4, road junction 1 mile north of, on road to Cape Vincent, at H. Robbin's house	340	L
Schoolhouse No. 8, road junction 1-4 mile east of	320	L
Schoolhouse No. 9, road junction at	300	L

COUNTY OF JEFFERSON — — Town of Champion.

Champion, road junction 1 mile south of......	1,133	L
Champion, road junction 1 1-2 miles south of..	1,325	L
Champion, road junction 2 miles south of, on town line, near schoolhouse No. 12.........	1,407	L
Champion, crossroads 2 3-4 miles west of, at A. Hadsell's cheese factory, near Townsend creek, on road to Rutland	796	L
Champion, road junction 2 miles north of, near Townsend creek and town line...........	1,062	L
South Champion post-office, crossroads at	1,128	L
South Champion, road junction 1 1-2 miles west of, on town line	1,104	L
South Champion, road junction 1-2 mile south of	1,125	L

COUNTY OF JEFERSON — Town of Ellisburgh.

Belleville, ground in front of hotel...........	458	L
Belleville, iron bridge over Sandy creek......	449	L
Belleville, crossroads south part of, near W. S. Power's house	448	L
Belleville, old railroad crossing near I. Goodenough's house, 3-4 mile northwest of.......	459	L

Mannsville railroad station..................	564	L
Mannsville, triangulation point 1 1-2 miles east of..................................	722	T
Pierrepont Manor, road in front of post-office..	624	L
Pierrepont Manor, railroad station, tracks....	588	L
Pierrepont Manor, road crossing 5-8 mile north-west of..................................	573	L
Pierrepont Manor, road junction 3-4 mile east of..................................	641	L
Pierrepont lake, north pond.................	247	L
Sandy creek, bridge over, near H. Buel's house,	492	L
Schoolhouse No. 30, road junction near........	595	L
Schoolhouse No. 30, 1 mile east of, road in front of W. H. Balch's house, on road to North Boylston..................................	724	L
Wardwell, crossroads at.....................	516	L
Wardwell, sawmill dam.....................	509	L
Wardwell, road crossing 1 1-2 miles east of, on road to Adams.........................	548	L
Woodville, hotel piazza	318	L
Woodville, base of pump near flagpole........	315	L
Woodville, middle of bridge over Sandy creek..	321	L
Woodville, road junction just across bridge from..................................	310	L
Woodville, crossroads 3-4 mile west of, near Ellsworth's house	294	L

COUNTY OF JEFFERSON — Town of Henderson.

Robert's Corner, crossing of abandoned railway over highway 3 4 mile west of.............	450	L
Six Town pond, water level..................	418	L
Six Town pond, crossing of abandoned railroad on road just north of.....................	446	L
Smithville, south end of, junction of road going west..................................	358	L
Smithville, bridge over Stony creek...........	347	L

COUNTY OF JEFFERSON — Town of Hounsfield.

Alverson, rail in front of station	407	L
Camp's Mills, rail in front of station..........	375	L
East Hounsfield, tracks in front of railroad station	399	L
East Hounsfield, post-office, ground level......	478	L
Lake Ontario, mean level	247	L
Sacketts Harbor, rail in front of station......	252	L
Schoolhouse No. 15, road junction near, across Black river south of Brownville............	344	L
Schoolhouse No. 17, crossing of abandoned railroad from Sacketts Harbor to Pierrepont Manor near	312	L

COUNTY OF JEFFERSON — Town of Le Ray.

Black River, junction Main and School streets..	547	L
Black River P. O., crossroad 1 3-4 miles west of,	530	L
Sandford Corners railroad station............	472	L
Sandford Corners, road junction 3-4 mile west of, on town line............................	448	L
Sandford Corners, railroad crossing 1 1-2 miles south of	523	L

COUNTY OF JEFFERSON — Town of Lorraine.

Grimshaw's house, bridge over stream at, on road from Lorraine to Worthville	1,102	L
Lorraine, road junction near grist mill	967	L
Lorraine, road junction 1 mile south of, near U. Grow's house	1,027	L
Lorraine, road junction 1 1-2 miles east of, in front of cheese factory	1,080	L
Schoolhouse No. 3, road junction in front of....	986	L
Schoolhouse No. 4, road junction in front of..	992	L
Schoolhouse No. 4, road junction 1 mile northwest of near A. Gillett's house............	917	L

Schoolhouse No. 10, crossroads in front of, near west border of the town of Lorraine........	750	L
Schoolhouse No. 10, crossroads 1 1-2 miles east of, at O. Cronk's house	837	L
Schoolhouse No. 11, road junction at.........	1,112	L
Schuyler's, A. B., house, road junction just north of, near north line Lorraine township..	985	L

COUNTY OF JEFFERSON — Town of Lyme.

Chaumont railroad station	291	L
Chaumont, railroad crossing 1 mile east of, near house of H. Copley..................	285	L
Three Mile bay railroad station	306	L
Three Mile bay, railroad crossing 3-4 mile east of, near house of J. Shaver................	308	L

COUNTY OF JEFFERSON — Town of Pamelia.

Pamelia railroad station, tracks	528	L
Schoolhouse No. 2, ground in front of........	447	L
Schoolhouse No. 2, road junction 1 mile northeast of, near Chas. Taskett's house........	422	L
Watertown, railroad crossing Cape Vincent R. R. two miles west of....................	383	L

COUNTY OF JEFFERSON — Town of Rodman.

East Rodman (Whitesville) foot of flagpole opposite hotel	929	L
East Rodman, first bridge crossing Sandy creek, 1-4 mile east of	930	L
East Rodman, second bridge crossing Sandy creek, 1-2 mile east of	935	L
Rodman, crossroads in front of hotel.........	726	L
Rodman, road junction 1 1-2 miles southwest of, near S. Maxon's house	683	L
Sandy creek, crossroads across, just north of schoolhouse No. 4	862	L
Schoolhouse No. 7, crossroads at, southwestern part of township	962	L

Schoolhouse No. 7, crossroads 1 1-2 miles east of	1,072	L
Schoolhouse No. 11, crossroads 3-8 mile south of	1,238	L
Tremaines Corners, crossroads	1,134	L
Tremaines Corners, crossroads 1 1-4 miles south of, near S. Louck's house	1,194	L
Tremaines Corners, crossroads 1 1-4 miles east of, near M. Babbitt's house	1,238	L
Tremaines Corners, road, 2 miles east of, in front of G. Glazier's house	1,322	L
Unionville, road in front of schoolhouse No. 3,	790	L
Unionville, road junction 1 1-2 miles north of, near G. Flander's house	845	L
Unionville, crossroads 1 1-2 miles east of, at W. Glazier's house	835	L

COUNTY OF JEFFERSON — Town of Rutland.

Black River railroad station	550	L
Black River, railroad crossing 1 mile southwest of	521	L
Felts Mills railroad station	602	L
Fisher, J., railroad crossing in front of house of, between Black River and Felts Mills	560	L
Johnson triangulation point 1 1-4 miles west of Rutland Center — base of signal	1,033	T
Rutland Center, road in front of schoolhouse No. 6	963	L
Rutland Center, 1 1-4 miles west of, on road to Watertown, at O. Johnson's house	939	L
Schoolhouse No. 12, road in front of	647	L
Schoolhouse No. 12, road junction 3-4 mile south of, near B. Beavitt's house	683	L
South Rutland (Tylerville), road in front of post-office	1,054	L
Tylerville, road junction 1-2 mile southwest of, near E. Maltby's house	1,038	L

Tylerville, road junction 1 mile northeast of, near F. Day's house	1,064	L
Tylerville, road in front of D. Waldo's house, 2 miles east of	1,110	L

COUNTY OF JEFFERSON — Town of Watertown.

Boynton triangulation point, base of signal (1-2 mile east of schoolhouse No. 3, near J. Priest's house)	976	L
Burrs Mills, road junction at hotel	784	L
Burrs Mills, bridge over mill stream	807	L
Burrs Mills, road on top of hill, 3-4 mile south of, in front of G. Yender's house	930	L
Burrs Mills, road fork 1 mile south of, near J. P. Wilson's house	902	L
Burrs Mills, crossroads 1-2 mile west of, at L. D. Hill estate	777	L
East Watertown, road corner at hotel	753	L
Field Settlement, railroad crossing 1 mile east of, near L. and F. Ives' house	470	L
Rices station, railroad crossing at	480	L
Rices station, railroad crossing 3-4 mile south of, near G. Hart's house	501	L
Schoolhouse No. 3, road junction 1-5 mile south of	844	L
Schoolhouse No. 10, road bend 1 1-2 miles southwest of, at J. Priest's house	899	L
Watertown, primary bench mark, public square,	461	L
Watertown, Sewall's island, dam above	465	L
Watertown, water-works, dam at	483	L
Watertown, Beebe's island, dam above	429	L
Watertown, dam above lower railroad bridge,	397	L
Watertown, city reservoir, maximum water level	637	L
Watertown, ground at junction of State and Hunt streets	510	L
Watertown, rail in front of railroad station	448	L

Watertown, rail at crossing of Cape Vincent railroad and Main street	398	L
Watertown, rail at crossing of Haney street..	399	L
Watertown, rail at crossing of Dorsey street,	402	L
Watertown, rail at crossing of Smith street..	404	L
Watertown, rail at crossing of Willow street,	405	L
Watertown, rail at crossing of Cross street...	421	L
Watertown, rail at junction of Sacketts Harbor and Rome, Watertown and Ogdensburg railroad	411	L
Watertown, railroad crossing, Coffeen street..	424	L
Watertown, railroad crossing, Arsenal street..	412	L
Watertown, railroad crossing, High street....	474	L
Watertown, railroad crossing, Pine street....	424	L
Watertown, railroad crossing, Water street...	489	L
Watertown, railroad crossing, Hunt street....	518	L
Watertown, railroad crossing, Massey street..	440	L
Watertown, road junction near southwest corner of, near H. Fuller's house, Ridge road,	640	L

COUNTY OF JEFFERSON — Town of Worth.

Dennig's sawmill, road junction at, near east border of Lorraine township...............	1,670	L
Schoolhouse No. 3, road at..................	1,362	L
Sshoolhouse No. 7, road junction at..........	1,557	L
Worthville crossroads, base of flagpole........	1,237	L
Worthville, crossroads 1 mile west of, near L. Bullock's house	1,174	L
Worthville, road junction 1 mile southeast of, front of O. Greenley's house	1,347	L
Worthville, road junction 2 1-2 miles southeast of, near J. Ellsworth's house..............	1,513	L

COUNTY OF LEWIS — Town of Pinckney.

Barnes' Corners, ground in front of hotel......	1,412	L
Barnes' Corners, three corners 3 miles nothwest of, on road to East Rodman...............	1,285	L

Carl triangulation point, base of signal, 2-3 mile northeast of Cronk's Corners..............	1,530	T
Cronk's Corners, road junction 1 1-3 miles south of and 3 3-4 miles northeast of Barnes' Corners, on the road to Pinckney.............	1,556	L
Cronk's Corners, crossroads 2 miles northeast of and 1-2 mile south of junction of towns of Rodman, Champion and Denmark..........	1,468	L
Green triangulation point, base of signal, 1 mile west of Cronk's Corners....................	1,426	T

COUNTY OF MADISON — Town of Lenox.

Allis, Geodetic station, New York State Survey, monument on hill north of road, 1 3-4 miles northeast of Canaseraga station......	503	T
Bulger, New York State Survey, Geodetic station; highest point on road 2 miles southwest of Oneida Castle	833	T
Canastota, tracks at station, W. S. R. R.....	434	L
Canastota, New York State Geodetic station on hill 1 mile east of....................	588	T
Canastota, three corners, 2 miles from, on road to Whitelaw	410	L
Canastota, E. C. & N. R. R. crossing 3 miles north of	415	L
Clockville, four corners in village	687	L
Cranson, Geodetic station, N. Y. State Survey, monument on hillside south of road, 1 3-4 miles east of Perryville	1,321	T
Durhamville, bridge over Oneida river 2 1-2 miles northwest of	390	L
Hobokenville, base of flagpole...............	590	T
Merrillsville, hill 2 miles west of.............	1,310	T
Oneida, N. Y. C. & H. R. R. R. tracks at station,	440	L
Oneida lake, three corners 1 mile east of......	397	L
Oneida reservoir, 2 miles south of Oneida....	640	L
Wampsville, W. S. R. R. tracks at station....	451	L
Whitelaw, four corners in village............	439	L

COUNTY OF MADISON — Town of Stockbridge.

Valley Mills, N. Y., O. & W. R. R. tracks at station	685	L
West Stockbridge hill, 2 miles west of Valley Mills	1,408	T

COUNTY OF MADISON — Town of Sullivan.

Bridgeport mill-pond, Chittenango river	381	L
Canaseraga, N. Y. C. & H. R. R. R. tracks at station	421	L
Chittenango, N. Y. C. & H. R. R. R. tracks at station	416	L
Chittenango, ground at drinking fountain	459	L
Chittenango, Pinnacle hill	725	T
Cotton, hill just west of	920	T
Lakeport, four corners in village	381	L
Lakeport, long flat two miles south of	386	L
Lakeport, schoolhouse at corners 1 1-2 miles southwest of	423	L
Lakeport, schoolhouse at three corners, 3 miles west of	406	L
North Manlius, schoolhouse 1 1-2 miles north of,	405	L
Oniontown, floor of bridge over Douglad ditch,	394	L
Perryville, E. C. & N. R. R. tracks at station	1,041	L
Whitelaw, three corners 2 miles west of	423	L

COUNTY OF MONROE — Town of Brighton.

Allen creek, Auburn railroad, track at crossing 1 mile west of	464	L
Auburn railroad, track at crossing of, 2 1-3 miles north of Pittsford station	460	L
Auburn railroad, track at crossing of Allen creek	462	L
Auburn railroad, track at crossing 2 miles north of Pittsford station	453	L
Brighton, track at road crossing 1-2 mile west of station	467	L

Brighton, track at Auburn railroad junction,	459	L
Brighton, track at station	459	L
Brighton, track at road crossing 1 1-2 miles east of station	434	L
Brighton, road crossing 1-4 mile north of railroad station	441	L
Brighton, road crossing 3-4 mile north of railroad station	406	L
Brighton, Auburn railroad, track at crossing 3-4 mile south of	461	L
Fair ground, track N. Y., L. E. & W. R. R....	537	L
Ridgeland, road forks at	555	L
West Brighton, four corners 1-2 mile south of, on Ridgeland road	572	L
West Brighton, crossing Henrietta road and South avenue	579	L
West Brighton, Rapids crossing and W. N. Y. & P. R. R., 1-2 mile west of...............	525	L

COUNTY OF MONROE — Town of Chili.

Black creek, track at crossing B., R. & P. R. R..	527	L
Brookdale, track at crossing 1 mile north of, on B., R. & P. R. R...........................	527	L
Brookdale, track at station B., R. & P. R. R....	524	L
Brookdale, track at crossing 2 miles south of, on B., R. & P. R.........................	528	L
Brookdale, B. R. & P. R. R. track at crossing 2 1-2 miles south of.....................	528	L
Brookdale, track at crossing 3 1-2 miles south of, on B., R. & P. R. R.....................	552	L
Brookdale, three corners 2 miles west of railroad station at	538	L
Chili, four corners at hotel..................	586	L
Chili, four corners west of hotel............	582	L
Chili, three corners 1-2 mile southwest of hotel,	557	L
Genesee Junction, track W. N. Y. & P. R. R....	525	L
Maplewood, B., R. & P. R. R. track at station..	530	L

Maplewood, B., R. & P. R. R. track at road crossing 1-2 mile north	537	L
Maplewood, B., R. & P. R. R. track at road crossing 1 mile north of	535	L
Scottsville, three corners 3 1-2 miles north of post-office	564	L
Scottsville, four corners 2 miles north of post-office	535	L
Scottsville, three corners 1 1-4 miles north of post-office	581	L
Scottsville, three corners 1 1-8 miles north of post-office	610	L
Whites, track at W. N. Y. & P. R. R. station	525	L
W. N. Y. & P. R. R., track at crossing 1-2 mile south of Genesee junction	525	L
W. N. Y. & P. R. R., track at crossing 2 3-4 miles north of Genesee junction	525	L
W. N. Y. & P. R. R., track at crossing 1 1-2 miles north of Genesee junction	525	L
W. N. Y. & P. R. R., track at crossing 3-4 miles north of Genesee junction	525	L
W. N. Y. & P. R. R., track at crossing 1 1-2 miles north of Scottsville	532	L
West Shore junction, track at	524	L
West Shore junction, four corners 3 miles west of	576	L

COUNTY OF MONROE — Town of Gates.

B., R. & P. R. R., track at Genesee Valley railroad crossing	535	L
B., R. & P. R. R., track at Chili road crossing	545	L
B., R. & P. R. R., track at Rapids road crossing,	561	L
Butchers Crossing, N. Y. C. & H. R. R. R. tracks	538	L
Cold Water, three corners 1 mile north of railroad station	577	L
Cold Water, track at railroad station	558	L

Cold Water, track at road crossing 1 1-2 miles east of station	560	L
Cold Water, track at road crossing 2 1-2 miles east of station	554	L
Gates, three corners 3 1-2 miles west of, on town line	561	L
Gates, Greece and Ogden towns, four corners at town boundary corners of	570	L
Lincoln Park, track at crossing of N. Y. C. & H. R. R. R. and Lincoln Park and Charlotte railroad	538	L
Lincoln Park, track at junction of N. Y. C. & H. R. R. R. and W. N. Y. & P. R. R.	538	L
L. P. & C. R. R., track at Lyell avenue crossing,	539	L
South Greece, track at road crossing 1 1-2 miles east of station	531	L
South Greece, track at road crossing 2 1-2 miles east of station	531	L
West Greece, four corners 3 1-2 miles south of,	586	L

COUNTY OF MONROE — Town of Greece.

Barnard crossing, Charlotte railroad, track at station	400	L
Barnard crossing, Charlotte railroad, track at crossing 1-4 mile south of station	405	L
Barnard crossing, track at connecting switch B., R. & P. R. R. and Charlotte R. R. 3-4 mile north of station	399	L
Barnard crossing, track at station, L. P. C. R. R.	398	L
Charlotte, crossing of R., W. & O. and Charlotte railroads	260	L
Charlotte railroad, track at mile-post, "Rochester, 7 miles; Ontario Beach, 3 miles"	384	L
Charlotte railroad, track at Lake avenue crossing	351	L
Charlotte railroad, track at mile-post, "Rochester, 8 miles; Ontario Beach, 2 miles"	329	L
Charlotte railroad, switch to Yates dock	322	L

Charlotte railroad, track at mile-post, "Rochester, 9 miles; Ontario Beach, 1 mile"	272	L
Greece, four corners in village	433	L
Greece, door-sill of church	438	L
Greece, four corners 1 mile north of church	393	L
Greece, three corners 1 1-2 miles north of church	373	L
Greece, four corners 2 miles north of church	347	L
Greece, three corners 1 mile south of	452	L
Greece, three corners 3-4 mile south of	448	L
Greece, three corners 1-2 mile south of	441	L
Latta, L. P. & C. R. R., track at crossing	289	L
Little Ridge road, crossing of L. P. & C. R. R.	431	L
L. P. & C. R. R., at R., W. & O. R. R	277	L
North Greece, four corners in village	340	L
North Greece, three corners at stone church 1 mile west of	345	L
North Greece, three corners 1 mile east of	314	L
North Greece, four corners 2 miles east of	327	L
South Greece, track at railroad station	536	L
South Greece, track at mile-post, "Niagara Falls, 71 miles"	527	L
South Greece, Erie canal at road crossing 1 mile west of	509	L
West Greece, three corners at hotel	451	L
West Greece, three corners 1 mile south of church	551	L
West Greece, three corners 1 mile north of church	385	L
West Greece, four corners 2 miles north of church	362	L

COUNTY OF MONROE — Town of Henrietta.

Henrietta, four corners in village	600	L
Henrietta, three corners 1 mile southeast of	652	L
Henrietta, first railroad crossing on Rochester branch of Lehigh Valley railroad, 2 1-2 miles south of	604	L

Henrietta, three corners 3-4 mile south of.....	601	L
Henrietta, four corners 1-2 mile north of......	580	L
Red creek, track at station	539	L
Ridgeland, track at station	539	L
Rush Reservoir, three corners 1-4 mile east of,	677	L
West Henrietta station, track N. Y., L. E. & W. R. R.	564	L

COUNTY OF MONROE — Town of Irondequoit.

Irondequoit, road crossing at post-office......	434	L
Irondequoit, road junction 1-3 mile south of post-office	405	L
Irondequoit, road junction 1-2 mile north of post-office	405	L
Irondequoit bay, water level	247	L
Irondequoit, road crossing 1 mile south of post-office	449	L
Irondequoit, road crossing 1 1-4 miles west of post-office	432	L
Irondequoit, Ridge road and Hudson street.....	430	L
Irondequoit, Ridge road and Clinton street...	431	L
Irondequoit, Ridge road and Hollenbeck street,	427	L
Irondequoit, Ridge road and Paul street......	423	L

COUNTY OF MONROE — Town of Mendon.

Mendon, four corners near post-office..........	577	T
Mendon, three corners 1 1-4 miles NNE. of...	600	T
Mendon, three corners 1 mile west of post-office,	602	T
Mendon Center, four corners 2 3-4 miles north of post-office	731	T
Mendon Center, four corners 3-4 mile northeast of post-office	701	T
Mendon Center, four corners 1 miles west of post-office	669	T
Mendon Center, three corners 2 miles west of post-office	674	L

Mendon pond, surface of water	662	L
Mendon pond, foot of big tree at four corners 1-4 mile northeast of	680	L
Mendon pond, three corners 1-4 mile northwest of, near two houses southeast of road corner,	697	L

COUNTY OF MONROE — Town of Pittsford.

Auburn railroad, track at mile-post "Rochester 9 miles"	440	L
Auburn railroad, track at mile-post "Rochester 10 miles"	457	L
Auburn railroad, track at mile-post "Rochester 12 miles"	455	L
Auburn railroad, track at mile-post "Rochester 13 miles"	454	L
Auburn railroad, track at mile-post "Rochester 8 miles"	436	L
Cartersville, track at Auburn railroad station,	477	L
Cartersville, track at crossing 3-4 mile south of station	458	L
Cartersville, Auburn railroad track at crossing 1 1-2 miles south of station............	446	L
Cartersville, track at crossing 1 3-4 miles south of station	451	L
Pittsford, track at Auburn railroad station...	459	L
Pittsford, track at crossing of Auburn railroad and West Shore railroad	457	L
Pittsford, Auburn railroad track at crossing 1-2 mile south of station	456	L
Pittsford, Auburn railroad track at crossing 1 mile south of station	464	L
Pittsford, Auburn railroad track at crossing of Erie canal, 1 1-4 miles south of station...	476	L
Pittsford, Auburn railroad track at crossing 1 mile north of station	430	L

COUNTY OF MONROE — City of Rochester.

Ames street junction of N. Y. C. & H. R. R. R. and Falls branch tracks	526	L
Brown street station, tracks N. Y. C. & H. R. R. R.	522	L
Charlotte junction, Falls branch, N. Y. C. & H. R. R. R., tracks	519	L
East Rochester station, N. Y. C. & H. R. R. R. tracks	490	L
Elmwood avenue, city line crossing at.......	563	L
N. Y. C. & H. R. R. R. and B., R. & P. R. R. junction, tracks at	529	L
N. Y. C. & H. R. R. R., main depot	514	L
N. Y., L. E. & W. R. R. station, tracks........	490	L
State dam, east side of Genesee river, top of masonry on	517	L
State dam, surface of water at..............	508	L
State dam, surface of water at foot of........	504	L

COUNTY OF MONROE — Town of Rush.

North Rush, four corners of post-office......	634	T
North Rush, four corners 2 miles east of post-office	622	T
North Rush, three corners 2 1-2 miles east of post-office	632	T
Rush reservoir, bench-mark on top of coping,	756	L
Rush reservoir, three corners 1-2 mile south-east of	665	T
Rush reservoir, four corners 1-4 mile west of..	690	T
Scottsville, track N. Y., L. E. & W. R. R. station	556	L
Scottsville hill, Geodetic station, United States Lake Survey	796	L

COUNTY OF MONROE — Town of Wheatland.

Scottsville, track at station, W. N. Y. & P. R. R.,	541	L
Scottsville, track at station, B., R. & P. R. R..	563	L
Scottsville, track at crossing 1-4 mile north of station, B., R. & P. R. R.	571	L
Scottsville, track at first road crossing south of B., R. & R. R. station	566	L
Scottsville, track at second and third road crossings south of B., R. & P. R. R. station, each	580	L
Scottsville, four corners 1-2 mile north of post-office	581	L
Scottsville, three corners 1-4 mile north of post-office	565	L
Scottsville, three corners at blacksmith shop..	555	L
Scottsville, south end of triangle at three corners by Cargill House	553	L
Scottsville, level of water at dam	532	L
Scottsville, four corners 1 mile south of post-office	583	L
Scottsville, tracks W. N. Y. & P. R. R. 1 mile south of station	541	L
W. N. Y. & P. R. R., track at road crossing 3-4 mile north of Scottsville station	532	L

COUNTY OF NIAGARA — Town of Cambria.

Cambria, large flat stone in front of brick schoolhouse	398	L
Cambria, floor of iron bridge over Twelve Mile creek, 1-2 mile west of four corners	389	L
Dickersonville, door-sill of brick schoolhouse 1 1-2 miles east of	394	L
Dickersonville, three corners 2 3-4 miles east of,	396	L
Lockport junction, first road crossing west of railroad station	624	L

Lockport junction, four corners 1-2 mile south of railroad crossing	627	L
Lockport junction, three corners 1 1-2 miles south of railroad crossing	619	L
Lockport junction, second road crossing (2 miles) west of railroad station	617	L
Lockport junction, third road crossing (3 miles) west of railroad station	619	L
Lockport junction, fourth road crossing (overhead), 3 1-3 miles west of railroad station..	631	L
Molyneaux hotel, foot of large post at pump in front of	396	L
Molyneaux hotel, three corners 1 mile east of,	400	L
Pekin, stone at northeast corner of road junction, 1-5 mile east of hotel	637	L
Pekin, triangulation station, 1-2 mile east of hotel	661	T
Pekin, United States reference monument at bend in road, 400 feet south of Pekin triangulation station	646	L
Sanborn, track at crossing 1 3-4 miles east of railroad station	635	L
Warren Corners, sill of south door of church,	403	L
Warren Corners, four corners 1 1-4 mile south of church	406	L

COUNTY OF NIAGARA — Town of Lewiston.

Dickersonville, doorsill of First M. E. Church,	396	L
Dickersonville, road opposite schoolhouse....	393	L
Dickersonville, top of log on culvert, junction Pekin and Ridge roads	396	L
Dickersonville, four corners 1 1-4 miles west of,	394	L
Dickersonville, three corners 1 mile east of First M. E. Church	391	L
Dickersonville, three corners 1 mile north of..	338	L
Lewiston, doorsill of American House........	286	L
Lewiston, N. Y. C. & H. R. R. R. track at station	292	L

Lewiston, N. Y. C. & H. R. R. R. track at freight station	358	L
Lewiston, west end of coping on viaduct crossing N. Y. C. & H. R. R. R..................	386	L
Lewiston, Niagara river at	249	L
Ridge, ground at top of ridge north of R., W. & O. R. R. station at Lewiston	620	T
Ridge road, crossing R., W. & O. R. R.........	428	L
Ridge road, three corners 3 miles east of post-office, road north	410	L
Pekin, large stone, southeast corner four corners at hotel	644	L
Pekin, four corners 1-2 mile north of.........	542	L
Sanborn, track at station	639	L
Sanborn, four corners 1-2 mile north of.......	644	L

COUNTY OF NIAGARA — Town of Niagara.

Gill creek, road crossing Falls branch of N. Y. C. & H. R. R. R. 0.3 mile east of..........	591	L
Gill creek, road crossing Falls branch of N. Y. C. & H. R. R. R. 0.4 mile east of..........	569	L
LaSalle, Niagara river at	566	L
LaSalle, N. Y. C. & H. R. R. R. track at station	575	L
Niagara Falls, track at station..............	571	L
Niagara Falls, east end abutment of canal bridge on N. Y. C. & H. R. R. R............	567	L
Niagara Falls, crest of falls	517	L
Niagara Falls, foot of falls	357	L
Niagara Falls, crossing N. Y. C. & H. R. R. R. and Erie avenue	580	L
N. Y. C. & H. R. R. R., mile-post "Niagara Falls 4 miles, Buffalo 18 miles"...............	575	L
N. Y. C. & H. R. R. R., mile-post "Niagara Falls 3 miles, Buffalo 19 miles"...............	572	L
N. Y. C. & H. R. R. R., mile-post "Niagara Falls 2 miles, Buffalo 20 miles"...............	569	L

N. Y. C. & H. R. R. R., mile-post "Niagara Falls 1 mile, Buffalo 21 miles"	572	L
Sanborn, overhead crossing 1-4 mile east of railroad station, top of rail	633	L
Suspension Bridge, north and south road crossing Falls branch N. Y. C. & H. R. R. R. 1 1-2 miles east of station at	601	L
Suspension Bridge, Michigan Central and N. Y. C. & H. R. R. R. grade crossing	577	L
Suspension Bridge, N. Y., L. E. and Grand Trunk railroad, grade crossing	573	L
Suspension Bridge, center of east tower of suspension bridge, copper bolt, United States Engineer Corps bench-mark	570	L
Suspension Bridge, track at station	579	L
Walmore, road crossing N. Y. C. & H. R. R. R. 1-2 mile north of	614	L

COUNTY OF NIAGARA — Town of North Tonawanda.

Batavia and Tonawanda branch of N. Y. C. & H. R. R. R., west end of bridge over Erie canal	583	L
Gratwick, track at N. Y. C. & H. R. R. R. station	576	L
Lockport, branch N. Y. C. & H. R. R. R. and N. Y., L. E. & W. R. R. crossing	577	L
North Tonawanda, N. Y. C. & H. R. R. R. station, tracks	575	L
N. Y., L. E. & W. R. R., track at crossing Tonawanda creek	587	L
Signal tower, N. Y. C. & H. R. R. R. and N. Y., L. E. & W. R. R. at North Tonawanda	576	L

COUNTY OF NIAGARA — Town of Pendleton.

Halls, track at railroad station	582	L
Halls, road crossing 1 1-2 miles northeast of railroad station	589	L

Halls, road crossing 1-2 mile southwest of railroad station	579	L
Halls, road crossing 1 mile southwest of railroad station	580	L
Mapleton, track at railroad station	594	L
Mapleton, road crossing 2 miles northwest of railroad station	617	L
Mapleton, four corners 1 1-4 miles east of railroad station	597	L
Pendleton, Center, railroad track at station	591	L
Pendleton enter, doorsill of church	621	L
Pendleton Center, five corners	593	L

COUNTY OF NIAGARA — Town of Porter.

Lake Ontario, surface of water	247	L
Ransomville, track at railroad station	324	L
Ransomville, three corners 1-2 mile south of	327	L
Ransomville, iron bridge over stream 3-4 mile north of	315	L
Ransomville, four corners 1 1-2 miles north of	312	L
Ransomville, doorsill of M. E. church, 3 miles north of	309	L
Ransomville, three corners 4 miles north of and 4 1-2 miles west of Wilson	265	L

COUNTY OF NIAGARA — Town of Wheatfield.

Bergholtz, three corners 1 mile east of	584	L
Sanborn, four corners 1 mile south of station	603	L
Sawyer, track of Lockport branch N. Y. C. & H. R. R. R. at station	575	L
St. Johnsbury, four corners in village	577	L
St. Johnsbury, top of stone step, brick (Dutch Reformed) church	580	L

COUNTY OF NIAGARA — Town of Wilson.

Lake Ontario, surface of water	247	L
North Wilson, three corners 1 1-4 miles north of	282	L

North Wilson, three corners 1 1-2 miles south of	343	L
North Wilson, three corners 2 1-2 miles south of	350	L
Wilson, track at railroad station	297	L
Wilson, four corners at Ontario House	281	L
Wilson, three corners 1 1-2 miles south of post-office	320	L
Wilson, three corners 3 miles south of post-office	347	L

COUNTY OF ONEIDA — Town of Floyd.

Floyd, ridgepole of church	612	T

COUNTY OF ONEIDA — Town of Lee.

Lee, ground at post-office	502	L

COUNTY OF ONEIDA — Town of Marcy.

Marcy, R., W. & O. R. R. tracks at station	587	L
Marcy, hill north of road, 2 miles east of village,	945	T

COUNTY OF ONEIDA — Town of New Hartford.

Chadwicks, D., L. & W. R. R. tracks at station,	716	L
Genesee, street crossing, W. S. R. R.	525	L
New Hartford, D., L. & W. R. R. tracks at station	535	L
Washington Mills, D., L. & W. R. R. tracks at station	611	L
Washington Mills, road crossing, D., L. & W., 1 mile south of	655	L
W. S. R. R., tracks at New Hartford, crossing D., L. & W. R. R.	504	L
West Shore railroad tracks over New York Mills road from New Hartford	504	L

COUNTY OF ONEIDA — Town of Paris.

Paris, hill just east of Paris Hill church	1,542	T
Paris, hill east of road, 1 mile north of Paris Hill	1,483	T

COUNTY OF ONEIDA — Town of Trenton.

Holland Patent, R., W. & O. R. R. tracks at station	630	L
Stittville, R., W. & O. R. R. tracks at station,	560	L

COUNTY OF ONEIDA — Town of Verona.

Churchville, three corners in village..........	450	L
Sconondoa, four corners 2 miles east of.......	530	L
Sconondoa, three corners 1-2 mile east of.....	475	L
Verona, four corners 2 1-2 miles northwest of,	464	L
Verona, N. Y. C. & H. R. R. R. tracks at station	467	L
Verona, four corners 1 1-2 miles east of	554	L
Verona Mills, mill-pond	433	L

COUNTY OF ONEIDA — Town of Rome.

Coonrod, R. W. & O. railroad crossing 3-4 mile south of	441	L
East Verona, four corners north of canal....	414	L
Greenway, four corners 1-3 mile north of......	466	L
Rome, N. Y. C. & H. R. R. R. tracks at station..	445	L
Rome, New York State Survey, Geodetic station 1-4 mile southeast of cemetery north of city	506	T
Rome, four corners 1 mile east of fair grounds,	485	T
Black River canal, level No. 1, junction with Erie canal in city of Rome, length 429 feet..	429.8	L
Black River canal, level No. 2, in city of Rome, length 1,094 feet	439.8	L
Black River canal, level No. 3, in city of Rome, length 927 feet	449.8	L
Black River canal, level No. 4, in city of Rome, length 2,121 feet	459.8	L
Black River canal, level No. 5, in town of Rome, length 3,455 feet	469.8	L

Black River canal, level No. 6, in town of Rome, length 3,631 feet	479.8	L
Black River canal, level No. 7, in town of Rome, length 2.87 miles	489.8	L

COUNTY OF ONEIDA — Town of Vernon.

Vernon, West Shore railroad station.........	598	L
Vernon, hill north of four corners, 2 1-2 miles southwest of	877	T
Vernon, road crossing W. S. R. R., 2 1-2 miles east of	646	L
Vernon Center, hill southeast of corners by schoolhouse, 2 miles southwest of	1,137	T

COUNTY OF ONEIDA — Town of Vienna.

North Bay, N. Y., O. & W. R. R. tracks at station	386	L
Oneida lake	370	L
Pine, Geodetic station, New York State Survey,	568	T
West Vienna, N. Y., O. & W. R. R. tracks at station	412	L

COUNTY OF ONEIDA — Town of Westmoreland.

Bartlett, N. Y., O. & W. R. R. tracks at station,	558	L
Clarks Mills, W. S. R. R. tracks at station...	520	L
Clinton, N. Y., O. & W. R. R. tracks at station,	583	L
Crow Hill, hill south of road 3 1-4 miles southeast of Clinton, and 2 miles north of Paris Hill	1,300	T
Dix, four corners 1 mile east of.............	602	L
Hecla, W. S. R. R. tracks at station..........	623	L
Hecla, road under W. S. R. R., 2 miles east of,	544	L
Kirkland, N. Y., O. & W. R. R. tracks at station	540	L
Lowell, four corners in village	588	L
Prospect Hill, New York State Survey, geodetic station, 4 miles southwest of Clinton......	1,380	T

Westmoreland, N. Y., O. & W. R. R. tracks at station	528	L
Westmoreland, four corners 4 miles west of..	685	T

COUNTY OF ONEIDA — Town of Whitestown.

Clarks Mills, road crossing W. S. R. R., 3 miles east of	522	L
Oriskany, N. Y. C. & H. R. R. R. tracks at station	423	L
Walesville, knoll 1 mile east of	613	T
Whitesboro, N. Y. C. & H. R. R. R. tracks at station	415	L

COUNTY OF ONONDAGA — Town of Camillus.

Belle Isle, hill east of road, 1 mile southeast of,	604	T
Fairmount Hill, New York State Survey geodetic station north of road, 1 1-2 miles west of Fairmount	736	T
Trump Hill, near Mr. Trump's house, Geddes..	593	T

COUNTY OF ONONDAGA — Town of Cicero.

Brewerton, railroad track at station	385	L
Brewerton, floor of bridge over Oneida river...	382	T
Cicero, four corners by cheese factory, 3 miles north of	394	T
Cicero, four corners north of hotel	395	T
Cicero Center, four corners in village	401	T
Cicero swamp, south of Cicero Center	395	L
Collamer, three corners on road, 2 1-2 miles from Bridgeport	390	L
North Syracuse, piazza of Wilber House	414	T
Oneida lake	370	L

COUNTY OF ONONDAGA — Town of Clay.

Brewerton, three corners 2 miles west of	380	L
Clay, railroad track at station	395	L
Clay, three corners 1 mile north of station	381	L

Euclid, four corners in village	375	L
Euclid, four corners 1 mile east of	406	L
Euclid, railroad crossing 1.7 miles west from	385	T
Euclid, four corners 1-2 mile north of	382	L
Woodard, railroad track at station	434	L
Woodard, four corners 1 mile northwest of station	393	L
Woodard, four corners 1.3 miles east of station	445	T
Young, three corners near red schoolhouse at	374	L
Young, three corners 1.2 miles northwest of	395	L

COUNTY OF ONONDAGA — Town of De Witt.

Collamer, four corners in village	457	L
Collamer, Syracuse road, 2 miles southwest of village	413	L
Collamer Hill, New York State Survey geodetic station	485	T
De Witt, tracks in front of N. Y. C. & H. R. R. R. station	414	L
De Witt, hill 1-2 mile south of East Syracuse reservoir and 1 mile northwest of	610	T
East Syracuse, hill 3-4 mile southwest of reservoir	685	T

COUNTY OF ONONDAGA — Town of Geddes.

Draper Hill, New York State Survey geodetic station	653	T
Erie canal, Jordan level	410	L
Fairmount, hill north of road 1 mile east of village	710	T
Onondaga lake	364	L
Pleasant branch, hill southwest of	529	T
Syracuse, hill 1-2 mile northwest of Providence House	650	T

COUNTY OF ONONDAGA — Town of Manlius.

Collamer, four corners 1 1-3 miles east of....	410	L
Collamer, four corners 3 miles east of.......	417	L
Eagle Hill, New York State Survey geodetic station; monument on hill south of school-house, 1.5 miles east of Eagle village.......	1,253	T
Eagle, hill north of road, 1 mile northeast of village	1,127	T
Fayetteville, track at railroad station, Chenango branch, W. S. R. R.................	538	L
Fayetteville, hill 1 mile west of	610	T
Green lake, hill just south of................	796	T
Kirkville, tracks at N. Y. C. & H. R. R. R. station	422	L
Kirkville, four corners 1 mile north of........	412	L
Kirkville, New York State Survey geodetic station, monument on hill south of canal, 1 mile east of village	507	T
Manlius station, N. Y. C. & H. R. R. R. tracks at,	416	L
Manlius Center, hill 1 1-2 miles west of.......	535	T
North Manlius, three corners at church.......	413	L

COUNTY OF ONONDAGA — Town of Onondaga.

Cossit hill, New York State Survey geodetic station, monument south of road, 1-2 mile west of Onondaga hill village..............	1,020	T
Jamesville, hill near tollgate road from Syracuse to	845	T
Onondaga hill, base of church	937	T
Onondaga valley, base of church............	439	T
Split rock, base of church..................	830	T
Syracuse, hill just west of new reservoir.....	688	T
Syracuse, hill 1 mile southwest of House of Providence	650	T

COUNTY OF ONONDAGA — Town of Salina.

Chestnut ridge hill, New York State Survey geodetic station, hill 1 mile north of salt sheds and 1 mile east of Liverpool village..	498	T
Onondaga lake	364	L

COUNTY OF ONONDAGA — Town of Syracuse.

Erie canal, Rome level, length 53 miles.......	428.8	L
Erie canal, short level, length 993 feet........	419.6	L
Erie canal, level between locks 48 and 49, length 3,770 feet	409.1	L
Erie canal, Syracuse level, length 5.014 miles..	402.1	L
Olympus, New York State geodetic station near Syracuse University	681.0	T
Oswego canal, level No. 1, junction of Oswego and Erie canals in Syracuse, length 1.71 miles,	402.1	L
Oswego canal, level No. 2, length 789 feet....	391.1	L
Oswego canal, level No. 3, length 660 feet....	380.1	L
Oswego canal, level No. 4, known as Liverpool level, length 5.42 miles	369.6	L
Syracuse, hill 1 mile southeast of university..	713.0	T

COUNTY OF OSWEGO — Town of Albion.

New Centerville, railroad crossing at	545	L
New Centerville, dam at	534	L
New Centerville, railroad crossing 1 1-2 miles south of, near Salmon river	545	L
New Centerville, road junction 1 1-3 miles due east east of, near Orwell line	585	L
Salmon river post-office, crossroads at	541	L
Salmon river, railroad bridge over, 1 1-2 miles north of Sand Bank	538	L
Sand Bank railroad station	564	L
Sand Bank, railroad crossing nearly a mile north of	538	L
Schoolhouse No. 5, crossroads at	504	L

COUNTY OF OSWEGO — Town of Boylston.

North Boylston, crossroads	967	L
North Boylston, road junction 1-2 mile north of,	993	L
North Boylston, top of hill middle of road 1-2 mile south of	1,063	L
North Boylston, road junction 1 mile due south of	1,028	L
North Boylston, crossroads 2 miles due south of,	1,039	L
Trout Brook, junction north of	1,041	L

COUNTY OF OSWEGO — Town of Constantia.

Constantia, N. Y., O. & W. R. R. tracks at station	382	L
Cleveland, N. Y., O. & W. R. R. tracks at station,	398	L
Oneida lake	370	L

COUNTY OF OSWEGO — Town of Richland.

Baldwin's crossroads	375	L
Baldwin's crossroads, crossroads 1-2 mile south-east of	399	L
Daysville railroad station tracks	305	L
Daysville, railroad crossing 1 1-2 miles south-west of and 1-2 mile north of town line	314	L
Hoff's sawmill, road junction just south of	326	L
Holmesville, railroad crossing at	387	L
Pulaski, rail of track nearest to station	380	L
Pulaski court-house, street in front of	373	L
Pulaski, Baptist church, sidewalk in front of	368	L
Pulaski, Methodist church, street in front of	372	L
Richland railroad station	524	L
Richland, railroad crossing 1 1-3 miles west of, on railroad to Pulaski	473	L
Salmon river, railroad bridge over	418	L
Salmon river, bridge over, on road to Pulaski from Pulaski railroad station	373	L

Schoolhouse No. 21, doorstep of	408	L
South Richland, bridge over Grindstone creek,	354	L
South Richland, crossroads 2 1-2 miles east of, on town line, between Richland and Albion,	470	L

COUNTY OF OSWEGO — Town of Sandy Creek.

Lacona railroad station	555	L
Lacona, railroad crossing 1 mile south of.....	548	L
Lacona, railroad crossing 2 miles south of.....	533	L
North pond	247	L
Sandy Creek, Watkins Hotel, stone sidewalk in front of	499	L
Sandy Creek railroad station, road junction 1-3 mile east of	589	L
South pond	247	L

COUNTY OF OSWEGO — Town of Schroeppel.

Euclid, north end of floor of drawbridge over Oneida river, on road to	376	L
Euclid, three corners 2 1-2 miles northwest of bridge over Oneida river to	421	L

COUNTY OF PUTNAM — Town of Carmel.

Baldwin Place, hill 2-10 mile northwest of....	773	L
Baldwin Place, hill 9-10 mile north of........	871	L
Kirk lake	583	L
Lake Mahopac	660	L
Mahopac Mines, hill 1-2 mile east of.........	975	L
Mahopac Mines, hill 1-2 mile north of.........	964	L
Tompkins Corner, hill 1 1-2 miles northeast of,	1,092	L

COUNTY OF PUTNAM — Town of Kent.

Boyds Corner reservoir, crest of wasteway......	593	L
Meads Corner, hill 1-2 mile west of...........	977	L
Meads Corner, hill 1 mile northeast of........	906	L

COUNTY OF PUTNAM — Town of Phillipstown.

Bull hill	1,425	L
Canada hill	842	L
Denning hill	1,046	T
Fort Defiance hill	1,050	T
Lake Surprise	705	L
Round hill	1,105	T
Solpue pond	545	T
Sugar Loaf hill	765	L

COUNTY OF PUTNAM — Town of Putnam Valley.

Brant lake	681	L
Brant lake, hill 1-4 mile south of	776	L
Oscawana lake	545	T
Oecor lake	565	L
Tompkins hill	1,145	T
Tompkins Corner, hill 6-10 mile east of	964	L

COUNTY OF PUTNAM — Town of Somers.

Amawalk, hill 6-10 miles east of	525	L
Amawalk, hill 3-4 miles northeast of	699	L
West Somers, railroad crossing 4-10 miles north of	528	L

COUNTY OF RENSSELAER — Town of Brunswick.

Ida lake	227	L
Mount Rafinesque	1,197	T
Quackenkill, hill 1-2 mile west of	1,265	T

COUNTY OF RENSSELAER — Town of East Greenbush.

Grandview hill	420	T
Hallenbeck hill	638	T
Teller hill	407	T

COUNTY OF RENSSELAER — Town of North Greenbush.

Bloomingdale hill	653	T
Defreestville, hill 2 miles east of	654	T

COUNTY OF RENSSELAER — Town of Pittstown.

Bald mountain	925	T
Johnsonville, tracks at station, Fitchburg railroad	363	L
Valley Falls, tracks at station, Fitchburg railroad	377	L

COUNTY OF RENSSELAER — Town of Schaghticoke.

Reynolds, trancks at station, Fitchburg railroad	172	L
Schaghticoke, tracks at station, Fitchburg railroad	276	L

COUNTY OF ROCKLAND — Town of Clarkstown.

High Tor	832	T
Hook mountain	730	T
Little Tor	710	T
Rockland lake	160	L
Rockland Lake Landing, hill 6-10 mile south of	610	T
Short Clove, hill 2-10 mile southeast of......	610	T
Waldberg Landing, hill 9-10 mile southeast of,	505	T
Waldberg Landing, hill 3-10 mile south of....	575	T

COUNTY OF ROCKLAND — Town of Orangetown.

Blauveltville, tracks at station Piermont branch N. Y., L. E. and W. R. R..................	167	L
Piermont, hill, 3-4 mile northwest of..........	680	T

COUNTY OF SARATOGA — Town of Ballston.

Ballston lake	285	L

COUNTY OF SARATOGA — Town of Half Moon.

Mechanicsville, Delaware and Hudson Railroad Company's tracks at station..............	107	L

COUNTY OF SARATOGA — Town of Malta.

Round Lake	188	T
Saratoga lake	217	L

COUNTY OF MONTGOMERY — Town of Amsterdam.

Amsterdam, track at N. Y. C. & H. R. R. R. station	277	L
Amsterdam, base of public school	481	L
Amsterdam, surface of Sanford's mill-pond....	438	L
Amsterdam, surface of reservoir	570	L
Cranesville, track at N. Y. C. & H. R. R. R. station	270	L
Fulton and Montgomery counties, monument at corner of	809	T
Hagaman, piazza of hotel	730	T
Hagaman, monument on Montgomery county line 1 mile northwest of	785	T
Manny Corners, road crossing	675	T
Saratoga and Schenectady counties, monument at corner of	703	T

COUNTY OF MONTGOMERY — Town of Florida.

Adebahr, New York State Survey, geodetic station	1,062	T
Dougal, New York State Survey geodetic station	1,075	T
Minaville, piazza of hotel	610	T
Minaville, summit 1 1-2 miles east	885	T
Minaville, summit 1 4-5 miles southwest	1,203	T
Minaville, base of yellow barn 1 1-2 miles west,	710	T
Minaville, base of yellow barn with cupola 1 mile north, on Amsterdam road	644	T
Port Jackson, track at West Shore railroad station	282	L
Port Jackson, road corner 1 1-2 miles south of,	742	T
Scotch Church, base of	978	T

COUNTY OF SCHENECTADY — Town of Duanesburgh.

Braman Corners, road in front of Baptist church	1,120	L
Braman Corners, road crossing 1-2 mile east of.	1,242	L
Braman Corners, road crossing 2-3 mile north-east of (foot of signboard)	1,249	L
Duanesburgh, doorsill of blacksmith shop	730	L
Duanesburgh, track at D. & H. R. R. station, Schenectady branch	676	L
Duanesburgh, road corner 1 1-4 miles west, on Albany turnpike	845	L
Duanesburgh, road corner 1 mile east, on Albany turnpike	775	L
Duanesburgh, doorsill of red house 2 miles east of, on Albany turnpike	883	L
Duanesburgh, doorsill of old gatehouse 3 miles east on Albany turnpike	899	L
Eaton Corners, road corners at	667	L
Eaton Corners, monument on county line 3-4 mile north	756	L
Eaton Corners, road corner 1 1-2 miles south,	942	L
Esperance, in front of Brooklyn Hotel	587	L
Esperance, road corner 1-2 mile east, on Albany turnpike	681	L
Esperance, road corner 2 1-2 miles east, on Albany turnpike	1,083	L
Esperance, road crossing 3 1-2 miles east, on Albany turnpike	1,040	L
Mariaville, base of Baptist church	1,306	T
Mariaville, surface of Mariaville pond	1,298	T
Mariaville, surface of Leatherstone lake	1,322	T

COUNTY OF SCHENECTADY — Town of Glenville.

Glenville, base of Baptist church	710	T
Glenville, road corner 1 mile southwest of	715	T
Brandmill, New York State Survey, geodetic station	1,097	T

Hoffman Ferry, N. Y. C. & H. R. R. R. track at station	264	L
Monument, at corner of Saratoga and Schenectady counties	703	T
Van Atten, New York State Survey geodetic Station	1,008	T

COUNTY OF SCHENECTADY — Town of Niskayuna.

Aqueduct, crest of dam in Mohawk river	205	L

COUNTY OF SCHENECTADY — Town of Princeton.

Kelley station, track at D. & H. depot	487	L
Princeton, base of white church square tower,	1,112	T
Princeton, New York State Survey geodetic station	1,434	T
Princeton, base of schoolhouse at road corner 1 miles east of	1,285	T
Rynex Corners, road crossing	1,070	T

COUNTY OF SCHENECTADY — Town of Rotterdam.

Pattersonville, track at West Shore railroad station	273	L
Rotterdam Junction, track at West Shore railroad station	293	L
Rynex Corners, road crossing	1,070	T
Schenectady, N. Y. C. & H. R. R. station, tracks,	246	L
South Schenectady, West Shore railroad station tracks	349	L
Waterstreet, New York State Survey, geodetic station	1,277	T

COUNTY OF SCHUYLER — Town of Catharine.

Cayuta lake, surface of water	1,272	T

COUNTY OF SCHUYLER — Town of Cayuta.

Alpine, top of rail at Lehigh Valley railroad station	1,140	L
Cayuta, top of rail at Lehigh Valley railroad station	1,114	L
Cayuta, summit 1 1-4 miles north of	1,788	L

COUNTY OF SCHUYLER — Town of Hector.

Cayutaville, schoolhouse at corners 1 mile due west of	1,341	T
Mecklenburg, corner of roads 1 mile due south of	1,302	T

COUNTY OF STEUBEN — Town of Corning.

East Corning, high summit 2 1-3 miles north of,	1,745	T
East Corning, high summit 1 4-10 miles south of	1,704	T
Quokenbush hill, northeast corner of township,	1,905	T

COUNTY OF TIOGA — Town of Spencer.

North Spencer, top of rail at Lehigh Valley railroad station	1,054	L

COUNTY OF TOMPKINS — Town of Danby.

Spencer Summit, L. V. R. R. crossing 1 1-4 miles north of	1,023	L
Stratton, L. V. R. R. crossing 1 mile south of,	760	L
West Danby, L. V. R. R. crossing 1 mile north of	792	L
West Danby, top of rail at L. V. R. R. station,	870	L

COUNTY OF TOMPKINS — Town of Enfield.

Cayutaville, summit of hill 1 mile northeast of,	2,045	T
Enfield Falls, corner of roads 2 miles west of,	1,487	T
Kennedy Corner, base of white church 1-4 mile west of	1,314	T
Kennedy Corner, summit 1 mile southwest of,	1,533	T
Perry City, base of white house, red roof, near corner, 1 1-4 miles southeast of	1,263	T

COUNTY OF TOMPKINS — Town of Ithaca.

Buttermilk Falls, railroad crossing opposite, 1 1-2 miles south of Ithaca	399	L
Buttermilk Falls, railroad crossing opposite, and at schoolhouse	403	L

Cayuga inlet, railroad bridge over, immediately south of Butternut creek	439	L
Glenwood, base of old barn south side of road to Ithaca, 3-4 mile from	771	T
Ithaca, Lehigh Valley Railroad station, top of rail	389	L
Ithaca, crossing of Lehigh Valley railroad, near fair grounds, immediately southwest of city,	387	L
Ithaca, railroad bridge over Cayuga inlet, 1 mile southwest of	393	L
Ithaca, railroad bridge over Cayuga inlet, 2 1-4 miles south of	410	L
Ithaca, base of large white house at corner of roads 3-4 mile northwest of, on road to Kennedy Corner	578	T
Ithaca, corner of roads 1 1-2 miles west of, on road to Kennedy Corner	977	T

COUNTY OF TOMPKINS — Town of Lansing.

McKinney, top of rail at Lehigh Valley Railroad station	392	L

COUNTY OF TOMPKINS — Town of Newfield.

Bull Hill, highest point in road over, in front of large barn	1,798	T
Butternut creek, Lehigh Valley railroad crossing, 1 mile south of, near National Hotel	461	L
Cayuta, barn on summit 1 mile east of	1,806	T
Newfield, base of Episcopal church	1,065	T
Newfield, high summit 3 miles southwest of, and 2 miles northeast of Pony Hollow	1,923	T
Nina, Lehigh Valley Railroad track opposite large brick mill 3-4 mile	488	L
Nina, top of rail at Lehigh Valley Railroad station	526	L
Pony Hollow, foot of large dead tree on high summit, 1 1-2 miles east of	1,923	T
Stratton, top of rail at Lehigh Valley Railroad station	659	L

COUNTY OF TOMPKINS — Town of Ulysses.

Enfield, base of large white house east side of road, 3 2-3 miles due north of	1,320	T

COUNTY OF ULSTER — Town of Esopus.

Esopus, tracks in front of railroad station, W. S. R. R.	116	L
Esopus, hill 1-2 mile northwest of railroad station	545	T
Huzzy Hill, hig wooded hill, 1 3-4 miles southwest of Port Ewen. Middle summit	933	T
Prospect Hill (U. S. G. S. and U. S. C. & G. S. station), smooth nearly bare hill east of the northern of the Esopus ponds, at monument southeast of summit	360	T
West Shore railroad, south end of railroad bridge over Rondout creek	158	L
West Shore railroad, crossing 1 1-2 miles north of Esopus station	131	L
West Shore railroad, Ulster Park station, first road crossing south of	149	L
West Shore railroad, Ulster Park station, first road crossing north of	171	L

COUNTY OF ULSTER — Town of Hurley.

Tonski mountain, west of road 2 miles south of Bearsville	1,310	T
Tonski mountain, hill 1 mile east of	1,310	T

COUNTY OF ULSTER — City of Kingston.

Kingston, tracks in front of West Shore R. R. station	185	L
"Terry" (U. S. G. S., and U. S. C. & G. S. station), northeast part of city, 1-4 mile from river, and 100 yards from edge of bluff. Base of monument	309	T
West Shore railroad, Flatbush avenue, crossing,	182	L

COUNTY OF ULSTER — Town of Olive.

Ticetonyx mountain, 2 miles east of Yankeetown	2,527	T

COUNTY OF ULSTER — Town of Saugerties.

Asbury, 1 mile south of, on road to Katsbaan, base of red-roofed yellow house, on east side of road	244	T
Esopus creek, railroad bridge over, 1 1-4 miles south of Mt. Marion station	162	L
Katsbaan, base of stone Dutch Reform church 3-4 mile north of	209	T
Malden, W. S. R. R. tracks in front of railroad station	148	L
Mt. Airy, gravel walk at edge of cliffs in front of Mt. Airy House	558	T
Mt. Marion (Mt. Paulding of U. S. C. & G. S.) 1 1-2 miles northwest of Mt. Marion railroad station, wooded	719	T
Mt. Marion, tracks in front of railroad station, W. S. R. R	171	L
Saugerties village, crossroads at Palmer House,	150	L
Saugerties, tracks in front of railroad station, W. S. R. R	159	L
Saugerties Station, wooded hill 1 1-4 miles west of, 1-3 mile north of road to Unionville	495	T
Unionville, wooded hill 1 mile southeast of and 1 mile west of West Shore railroad	561	T
West Camp, tracks in front of railroad station, W. S. R. R	123	L
West Camp, wooded hill 1-2 mile northwest of,	330	T
West Shore railroad, first grade crossing south of Saugerties station, 1 mile	172	L
West Shore railroad, second grade crossing, south of Saugerties station	165	L

West Shore railroad, grade crossing 1 mile north of Mt. Marion station	162	L
West Shore railroad, first road crossing north of Saugerties	147	L
West Shore railroad, second road crossing north of Saugerties	145	L
West Shore railroad, first road crossing north of Malden, floor of overhead bridge	165	L
West Shore railroad, first road crossing south of West Camp station	138	L

COUNTY OF ULSTER — Town of Ulster.

Lake Katrine, tracks in front of railroad station, West Shore railroad	173	L
West Shore railroad, private road crossing 1 1-2 miles north of Lake Katrine station	158	L
West Shore railroad, first road crossing south of Lake Katrine station, 1 mile	182	L
West Shore railroad, road crossing 2 miles south of Lake Katrine station — Saugerties and Kingston road	183	L

COUNTY OF ULSTER — Town of Woodstock.

Bearsville, hill south of road 1 mile southwest of	1,331	T
Bearsville, hill east of road 1 1-2 miles southeast of	1,190	T
Cooper lake, hill east of	1,515	T
Overlook mountain	3,150	T
Tobias mountain	2,540	T

COUNTY OF WASHINGTON.

Lake Champlain	101	L
Lake George	323	L

COUNTY OF WASHINGTON — Town of Argyle.

Argyle, hilltop 1 mile southeast of	687	T
Cossoyuna lake	495	L
South Argyle, hilltop 3-4 mile north of	740	T

Summit lake	745	L
Summit lake, hilltop 1 mile north of.........	1,009	T
Summit lake, hilltop 1-2 mile south of west end of	1,040	T

COUNTY OF WASHINGTON — Town of Cambridge.

Cambridge, railroad tracks in front of station,	471	T
Cobble hill	1,462	L

COUNTY OF WASHINGTON — Town of Dresden.

Chubbs Dock, railroad tracks in front of station	111	L
Dresden, foundation of church	410	T
Hogback mountain	1,600	T
Spruce mountain	1,917	T
Sugar Loaf mountain	1,951	T
The Diameter, west end of	1,845	T

COUNTY OF WASHINGTON — Town of Fort Ann.

Comstock, tracks in front of station.........	136	L
Comstock, Champlain canal at	130	L
Fort Ann, Champlain canal above locks	154	L
Fort Ann, Champlain canal below locks	132	L
The Pinnacle	1,571	T

COUNTY OF WASHINGTON — Town of Granville.

Granville, foundation of schoolhouse No. 5...	843	T
Granville, railroad crossing at Norton's switch, south of	412	L
Granville, top of upper dam	388	L
Granville, rail in front of station	403	L
Granville, first road crossing north of station..	384	L
Granville, D. & H. R. R. bridge No. 92, south of,	491	L
Granville, D. & H. mile-post, E. B., 33 south of..	491	L
Granville, D. & H. mile-post, E. B., 34 south of..	449	L
Granville, D. & H. mile-post, E. B., 35 south of..	418	L
Granville, D. & H. mile-post, E. B., 37 north of..	388	L

Middle Granville, top of rail in front of station,	396	L
Middle Granville, top of dam at	358	L
Middle Granville, D. & H. mile-post, E. B., 38 south of	397	L
Middle Granville, D. & H. mile-post, E. B., 39 north of	412	L
Middle Granville, D. & H. mile-post, E. B., 40 south of	408	L
North Granville, foundation of Methodist Episcopal church	328	T
Raceville, rail in front of station	395	L
Raceville, D. & H. mile-post, E. B., 41 south of,	394	L
Raceville, D. & H. mile-post, E. B., 42 south of,	391	L
Raceville, Vermont-New York State line, post on D. & H. R. R., north of..................	393	L
South Granville, foundation of church	440	T
West Granville Corners, crossroads at.......	325	T

COUNTY OF WASHINGTON — Town of Greenwich.

Battenville, mile-post (Greenwich, 4 miles)....	399	L
Battenville, road east of, leading to Jackson..	410	L
Battenville, road in front of post-office........	421	L
Battenville, crest of dam at.................	395	L
Battenville, bridge over Whittaker brook, 2 miles north of	418	L
Battenville, road to the northwest, 1,500 feet north of Whittaker brook bridge	422	L
Center Falls, road leading to Jackson, just west of	354	L
Center Falls, crest of dam at................	369	L
Center Falls, bridge over Trout brook........	385	L
Cossayuna, base of Baptist church...........	494	L
Cossayuna, road in front of post-office.........	492	L
Cossayuna, bridge over outlet of lake	516	L
East Greenwich, base of Presbyterian church,	440	L
East Greenwich, road in front of telephone office	437	L

East Greenwich, crest of dam at	430	L
East Greenwich, mile-post 9 miles to Greenwich House	458	L
Greenwich, high mountain in the northeastern corner of town	1,220	T
Greenwich, schoolhouse No. 7	481	T
Greenwich, first railroad crossing south railroad bridge over Battenkill	342	L
Greenwich, rail on railroad bridge over Battenkill	340	L
Greenwich, top of rail at railroad station	341	L
Greenwich, road in front of Greenwich House,	351	L
Greenwich, Main street, in front of Hamilton House	370	L
Greenwich, top of white post in front of Hamilton House	377	L
Greenwich, road in front of fire engine house No. 4	383	L
Greenwich, road junction in front of Baptist church	393	L
Greenwich, road junction at east end of village, road to Spraguetown	399	L
Greenwich, crest of lower dam	324	L
Greenwich, crest of upper dam	352	L
Greenwich, road in front of icehouse belonging to Hamilton House	354	L
Mud pond	451	L
Mud pond, bridge over brook just south of	450	L
North Greenwich, base of Methodist Episcopal church	491	T
Reservoir, hilltop 1-2 mile east of	861	T
Sawyer hill	933	T

COUNTY OF WASHINGTON — Town of Hampton.

Hampton hill	648	T
Thorn hill	1,179	T

COUNTY OF WASHINGTON — Town of Hartford.

Deck hill	1,087	T
Hartford, base of Baptist church	410	T
Hartford, base of Universalist church	394	T
Marrion hill	821	T
Pumpkin hill	987	T

COUNTY OF WASHINGTON — Town of Hebron.

Birck hill	1,266	T
Hebron mountain	1,057	T
Mount Tom	1,422	T
North Hebron, base of Baptist church	814	T
Pine hill	1,070	T
Reynold hill	1,017	T
West Hebron, base of Methodist Episcopal church	488	T

COUNTY OF WASHINGTON — Town of Jackson.

Clark lake	470	L
Colfax mountain	1,270	T
Dead lake	537	L
Hodge lake	535	L
Lauderdale lake	530	L
Schoolhouse lake	533	L

COUNTY OF WASHINGTON — Town of Kingsley.

Adamsville, base of church	392	T
Smith's Basin, top of rail in front of station	149	L
Smith's Basin, Champlain canal at	155	L

COUNTY OF WASHINGTON — Town of Putnam.

Lake George	323	L
Moore hill	1,061	T
Putnam, top of rail in front of station	111	L

COUNTY OF WASHINGTON — Town of Salem.

Huckleberry hill	1,380	T
Salem, mile-post (Salem, 2 miles) on road leading to Greenwood Cemetery	474	L
Salem, road in front of Catholic Cemetery	459	L
Salem, bridge over White creek at Greenwood Cemetery	455	L
Salem, top of rail in front of station	490	L
Salem, first public road crossing railroad north of station	521	L
Salem, D. & H. R. R. bridge, No. 102, south of,	538	L
Salem, D. & H. R. R. bridge, No. 101, south of,	556	L
Salem, D. & H. R. R. bridge, No. 100, north of,	582	L
Salem, D. & H. R. R. bridge, No. 99, north of	611	L
Salem, road crossing just north of D. & H. R. R. bridge, No. 101	556	L
Salem, base of schoolhouse No. 13	449	T
Salem, base of schoolhouse No. 1	500	T
Salem, base of schoolhouse No. 7	691	T
Shushan, top of rail in front of station	471	L
Scott pond, hilltop just east of	919	T
State Line, intersection north of Salem, with D. & H. C. Co. R. R	682	L
West Rupert, first public road crossing south of intersection of State Line and D. & H. C. Co. R. R	656	L

COUNTY OF WASHINGTON — Town of Whitehall.

Death rock	839	T
Fish hill	447	T
Hatch hill	1,020	T
Ore Bed hill	400	T
Osgood hill	577	T
Skeen mountain	524	T

Tub mountain	415	T
Warner hill	480	T
West mountain	1,877	T
Whitehall, Champlain canal above locks......	130	L
Whitehall, Lake Champlain	101	L
Whitehall, top of rail in front of railroad station	143	L
Whitehall, D. & H. bridge over Wood creek east of station	129	L
Whitehall, west end of switch at rock cut east of	258	L

COUNTY OF WESTCHESTER — Town of Cortlandt.

Dickerson hill	810	L
Dickerson pond	282	L
Gallows hill	443	L
Jacobs hill	604	L
Mohegan lake, hill 1-2 mile west of..........	582	L
Spitzenberg hill	545	L
Wallace pond	170	L

COUNTY OF WESTCHESTER — Town of East Chester.

Mount Vernon, track at N. Y., N. H. & H. R. R. station	114	L

COUNTY OF WESTCHESTER — Town of Greenburgh.

Elmsford, tracks at station, New York City and Northern railroad..................	173	L
Elmsford, hill 1 mile southeast of............	445	T
Kensico station, hill 4-5 mile southwest......	523	T

COUNTY OF WESTCHESTER — Town of Mamaroneck.

Larchmont, track at N. Y., N. H. & H. R. R. station	42	L

COUNTY OF WESTCHESTER — Town of Mt. Pleasant.

Buttermilk hill, 7-10 mile west of Unionville..	743	T
Kaakeoot hill, 1 mile northwest of Tarrytown..	504	T
Kensico reservoir, crest of wasteway........	250	L
Raynold hill, 1 mile north of Kensico reservoir,	565	T
Sarles hill, 1 mile north of Pleasantville......	725	L

COUNTY OF WESTCHESTER — Town of Newcastle.

Chappaqua, summit on New York and Harlem railroad, 2-10 mile north of station..........	317	L
Chappaqua hill, 3-4 mile north of Chappaqua..	739	T
Chappaqua, hill 1 mile southeast of..........	678	T
Chappaqua, road crossing New York and Harlem railroad, 1 1-2 miles north of..........	283	L
Merritts Corners, New York City and Northern railroad	345	L
Ryder hill	621	T

COUNTY OF WESTCHESTER — Town of New Rochelle.

New Rochelle, track at N. Y., N. H. & H. R. R. station	72	L

COUNTY OF WESTCHESTER — Town of Pelham.

Pelhamville, track at N. Y., N. H. & H. R. R. station	68	L
Pelham Manor, track at N. Y., N. H. & H. R. R. station	47	L

COUNTY OF WESTCHESTER — Town of West Chester.

Baychester, track at N. Y., N. H. & H. R. R. station	11	L
Westchester, track at N. Y., N. H. & H. R. R. station	39	L

COUNTY OF WESTCHESTER — Town of White Plains.

White Plains, New York and Harlem Railroad station, tracks at	201	L

COUNTY OF WESTCHESTER — Town of Yorktown.

Bald mountain	688	L
Croton lake, crest of wasteway	168	L
Jefferson valley, hill 6-10 mile south of	604	L
Mohegan lake	447	L
Mohansic lake	450	L
Osceola lake	422	L
Osceola lake, hill 1 1-4 miles south of	665	L
Pin Bridge, hill 6-10 mile south of	607	L
Shrub Oak, hill 1-2 mile south of	731	L
Yorktown, hill 1-2 mile south of	586	L
Yorktown Heights, hill 1 1-4 miles southeast of	703	L

APPENDIX.

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APPENDIX A.

Engineering Expenses for the Fiscal Year.

ORDINARY REPAIR FUND.

Chapter 89, *Laws* 1893 *and chapter* 297, *Laws* 1894.

DIVISION.	Canals.				
	Erie.	Champlain.	Oswego.	Black River.	Cayuga and Seneca.
Eastern	$9,390 29	$3,719 86	....	....	....
Middle	7,986 94	....	$353 82	$3,081 04	$19 73
Western	8,935 71	....	....	....	....
Totals	$26,312 94	$3,719 86	$353 82	$3,081 04	$19 73

Total $33,497 89

Extraordinary Canal Improvements.

Eastern Division.

Repairing Cohoes dam, chapter 643, Laws 1893, and chapter 462, Laws 1894	$4,069 72
Constructing stone dam at Little Falls, chapter 480, Laws 1893, and chapter 119, Laws 1894........	11 97
Improving Champlain canal, chapter 119, Laws 1893,	3,511 50
Lengthening berme lock No. 19, Erie canal, chapter 119, Laws 1893	4,003 14
Repairing Schoharie creek and upper and lower Mohawk aqueducts, chapter 5, Laws 1893.......	414 66

Construction of bridge at Ann street, Little Falls, chapter 197, Laws 1893	$184 39
Construction of bridge at Bridge street, Amsterdam, chapter 561, Laws 1893..................	315 61
Approaches to Van Derwerken farm bridge, Waterford, chapter 294, Laws 1893	286 00
Construction of bridge No. 15 (Fitzgerald's) Champlain canal, chapter 569, Laws 1893	330 32
Dredging Albany basin, chapter 141, Laws 1893..	846 98
Improving Saranac river, chapter 141, Laws 1893	141 43
Abating nuisances, Chemung canal and feeder, chapter 726, Laws 1893	54 15
Shinnecock and Peconic canal, chapter 726, Laws 1893	204 19
Strengthening and protecting berme bank near Schenectady, chapter 24, Laws 1894	3,241 00
Improving Champlain canal, chapter 572, Laws 1894	619 45
Lengthening lock No. 20, Erie canal, chapter 572, Laws 1894	457 91
Repairing Glens Falls feeder, chapter 278, Laws 1894	152 38
Repairing Rocky Rift feeder, chapter 594, Laws 1894,	61 59
Repairing mole at Houghtaling Island, chapter 358, Laws 1894	69 10
Abutments and approaches to an iron bridge at Mechanicville, chapter 594, Laws 1894..........	22 30
Lift bridge at Canajoharie, chapter 592, Laws 1894,	67 05
Survey State Board of Claims, chapter 726, Laws 1893, and chapter 358, Laws 1894..............	4,152 59
Shinnecock and Peconic canal, chapter 768, Laws 1893, and chapter 358, Laws 1894.............	861 80
	$24,139 23

Middle Division.

Lengthening lock No. 76, Black River canal, chapter 119, Laws 1893, and chapter 572, Laws 1894....	$710 65
Baldwinsville dam, chapter 113, Laws 1893......	2,843 23
Owagena lake, chapter 658, Laws 1893, and chapter 335, Laws 1894..............................	429 32
Twitchell creek, chapter 224, Laws 1893..........	131 00
Flow ground, clearing at Stillwater, chapter 119, Laws 1893	134 83
Bridge, Genesee street, Utica, chapter 560, Laws 1893	2,500 00
Sewer at Canastota, chapter 326, Laws 1893......	510 50
Butternut creek improvement, chapter 119, Laws 1893	471 76
Bridge, Mulberry street, Syracuse, chapter 610, Laws 1892	161 74
Bridge, at James street, Rome, chapter 562, Laws 1893	200 00
Bridge at Clinton street, Syracuse, chapter 57, Laws 1893	1,200 00
Survey, State Board of Claims, chapter 358, Laws 1894	928 58
Cayuga lake obstructions, chapter 279, Laws 1894..	294 14
State ditch Liverpool, chapter 119, Laws 1893......	500 00
Dam at Forestport, chapter 496, Laws 1894........	2,000 00
Locks, Black River canal, chapter 119, Laws 1893, and chapter 572, Laws 1894....................	710 65
Canandaigua pier and breakwater, chapter 173, Laws 1894	250 00
North Lake reservoir, chapter 726, Laws 1893......	392 07
Cayuga and Seneca canal protecting, chapter 424, Laws 1894	250 00
Madison Brook feeder, chapter 570, Laws 1894....	559 47
Bridge, Butternut creek, chapter 470, Laws 1894..	50 00
Wall, Gilbert street, Utica, chapter 423, Laws 1894,	76 97

Bridge, Geddes street, Syracuse, chapter 385, Laws 1894	$200 00
Whitesboro, drain, chapter 359, Laws 1894	57 57
	$15,562 48

Western Division.

Oak Orchard creek, chapter 136, Laws 1893	$2,034 46
Erie basin, Buffalo, chapter 119, Laws 1893	2,344 45
Broad street culvert, Tonawanda, chapter 244, Laws 1893	442 99
Buffalo bridges, chapter 153, Laws 1893	426 12
Improving canal, Buffalo, chapter 119, Laws 1893	874 99
Chemung canal nuisance, chapter 726, Laws 1893, and chapter 358, Laws 1894	1,165 12
Bridge, Ford street, Rochester, chapter 14, Laws 1893	176 57
Rochester wall, chapter 726, Laws 1893	135 40
Ohio basin, Buffalo, chapter 145, Laws 1894	730 11
Honeoye outlet, chapter 563, Laws 1893	1,266 73
Havana wall, chapter 345, Laws 1894	46 83
	$9,643 77

SPECIAL APPROPRIATIONS.

Examination, monuments and maps disbursed by division engineers, chapter 726, Laws 1893, and chapter 358, Laws 1894	$4,596 11
Examination, monuments and maps, paid directly by State Treasurer, chapter 726, Laws 1893, and chapter 358, Laws 1894	3,909 28
Genesee river, storage, chapter 726, Laws 1893	6.408 25
	$14,913 64

SUMMARY.

Ordinary repairs	$33,427 39
Extraordinary canal improvements	49,345 48
Special appropriations	14,913 64
Total engineering expenses	$97,686 51

FINAL ACCOUNTS PASSED IN THIS OFFICE DURING THE FISCAL YEAR ENDING SEPTEMBER 30, 1894.

Number.	CHARACTER OF WORK.	Name of contractor.	Engineer's estimate at contract prices.	Amount of final account.
1	Bridge at Ann street, Little Falls	Kellogg Iron Works	$2,728 80	$2,894 64
2	Bridge No. 15 (Fitzgerald's bridge), with abutments and approaches thereto	Cunningham & Monty	2,753 25	2,806 21
3	4,150 feet of vertical wall on the berme bank of the Erie canal near Schenectady, N. Y.	Troy Public Works Company	33,668 10	31,359 93
4	Machinery for drawing boats into lengthened lock No. 19	Wm. B. Wemple & Sons	1,200 00	1,200 00
5	Thirty-five bents for upper and lower Mohawk aqueducts	Buffalo Bridge & Iron Works	....	9,611 58
6	Lengthening at the foot of berme lock No. 19	John J. Hallock	29,459 80	28,718 08
7	Substructure of lift-bridge over the Erie canal at Water street, Albany	Hilt & Johnson	2,551 75	2,986 94
8	Superstructure of lift-bridge over the Erie canal at Water street, Albany	Hilt & Johnson	8,261 49	8,300 59
9	Substructure lift-bridge at Clinton street, Syracuse	Pidgeon & Co	4,234 00	5,406 26
10	Bridge over old abandoned Erie canal at South James street, Rome	Wm. J. Crammond	1,799 20	1,941 81
11	Highway bridge over Butternut creek	Ed. S. Candee	1,000 00	869 42
12	Superstructure lift-bridge, Clinton street, Syracuse	Wrought-Iron Bridge Company	7,000 00	7,971 60
13	Complete the reservoir dam above Forestport pond	Beckwith & Quackenbush	30,780 00	27,952 81
14	Superstructure lift-bridge, Mulberry street, Syracuse	Wm. H. Shepard & Sons	8,700 00	9,446 72
15	Sewer at Canastota	A. D. Osborn	6,139 60	6,332 81
16	Raising dam on Beaver river at Stillwater	F. Louis Faas & Co	13,220 00	11,724 17
17	Substructure lift-bridge, Mulberry street, Syracuse	Brummelkamp & Lane	2,144 65	2,288 07
18	Rebuilding lock No. 76, Black River canal	J. J. Hallock	12,535 00	12,706 69
19	Raising approaches to Seneca street bridge at Weedsport	W. H. Eldridge	810 00	776 40
20	Superstructure wrought-iron bridge over Erie canal at Madison street, Rome	Wm. H. Shepard & Sons	8,800 00	8,855 02
21	Highway leading east and west across head of Owagena lake (Cazenovia)	E. S. Candee	4,867 50	4,990 39
22	Spillway over falls and (paved waste) at Eaton Brook reservoir	Hughes Brothers	12,135 00	12,027 71
23	Dredging Erie basin, Buffalo	Hingston & Woods	20,320 00	23,794 91
24	Removing of obstructions from the prism of the Erie canal in the city of Buffalo	Hingston & Woods	7,873 00	6,981 07
25	Deepening and improving the channel of the Honeoye outlet	Michael Binnett	3,251 00	3,288 28
26	For iron (four) bridges over New York State canals in the city of Buffalo	Hilton Bridge Construction Company	15,725 00	15,725 00
27	A dry rubble wall on north side of Erie canal, between South street, Paul street and Pinnacle avenue bridges, city of Rochester	George H. Nagle	1,415 95	1,289 43
28	A bulkhead for Oak Orchard feeder in the village of Medina	MacGregor & Hughes	29,766 30	674 77
29	Wrought-iron bridge over the Erie canal at Ford street in the city of Rochester	Kellogg Iron Works	2,845 00	2,845 00
30	Abatement of nuisances on the Chemung canal feeder in Big Flats	James Robinson	2,387 60	2,522 67
31	Improving 6,500 feet of Champlain canal, from Wilbur's basin waste-weir, northerly	Troy Public Works Company	35,444 25	47,785 94
32	Bridge at Bridge street, Amsterdam	Kellogg Iron Works	2,362 70	3,247 34
33	Stone dam across Mohawk river at Little Falls, N. Y	Rapp & Company	9,964 00	12,984 94
34	Foot-bridge over Erie canal at Fifteenth street, West Troy	Hilton Bridge Construction Company	1,712 75	1,175 00
35	Construction of approaches to Van Der Werken farm bridge, Waterford	Troy Public Works Company	2,748 00	2,964 14

36	Completing at head of Owagena lake	Edward S. Candee	4,867 50	4,891 50
37	Improving channel of Butternut creek	John E. Pidgeon	9,000 00	6,798 35
38	Completion of pier and breakwater at Canandaigua lake	James Robinson	1,985 00	1,794 11
39	Cleaning State ditch at Liverpool	Edward S Candee	3,600 00	3,347 14
40	Arch culvert over State ditch on Broad street, Tonawanda, N. Y	E. H. Rogers	4,565 00	4,410 26
	Total			$349,176 15

TABLE OF CONTRACTS PENDING ON THE NEW YORK STATE CANALS ON THE 30TH DAY OF SEPTEMBER, 1894.

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Legislative. Chapter.	Legislative. Year.	Appropriation.	Engineer's estimate.	Engineer's estimate at contract prices.	Payments to date.
John Twomey	July 24, 1894	For lengthening at the foot berme lock No. 20	572	1894	$40,000 00	$35,005 35	$34,294 65	$5,406 00
Troy Public Works Co	Aug. 25, 1894	Improvements and repairs to Rocky Rift feeder	655	1891	8,000 00	7,094 75	....	....
Wm. B. Wemple Sons	July 24, 1894	Machinery for drawing boats into lock No. 20	572	1894	....	1,200 00	12,200 00	....
Flood & Sherrill	July 23, 1894	Vertical wall at Glens Falls feeder	278	1894	15,000 00	12,977 08	9,124 86	....
P. J. Brummelkamp	July 23, 1894	Piling and protecting the banks of the Shinnecock and Peconic canal	768	1894	15,000 00	12,865 80	12,547 80	4,352 00
P. J Brummelkamp	July 24, 1894	Restoring and protecting approaches to swing-bridge over Shinnecock and Peconic canal	358	1894	3,500 00	2,802 90	2,793 70	357 00
Wm. D. Fuller	July 23, 1894	Mole on Houghtaling island in Hudson river	358	1894	1,200 00	69[illegible] 00	935 00	....
Hughes Bros. & Bangs	Aug. 14, 1893	Stone dam at Baldwinsville	113 180	1893 1894	35,000 00 25,000 00	60,000 00	54,079 00	22,695 00
Hilton Bridge Construction Co.	Nov. 15, 1893	Two lift and one fixed bridge over Erie canal at Utica	*560	1893	45,000 00	....	....	36,610 00
A. C. Hall	Sept. 11, 1894	Sluice in North Branch reservoir	726	1893	8,000 00	7,992 60	6,592 60	....
A. Van Wagner & Co	July 23, 1894	Lock No 18, Black River canal	572	1894	....	18,837 50	17,087 50	....
Mulcahy & Co	July 23, 1894	Lock No. 28, Black River canal	572	1894	....	17,770 50	15,970 50	....
Mulcahy & Co	July 23, 1894	Lock No. 37, Black River canal	572	1894	....	17,091 00	15,294 00	....
J. J Hallock	Aug. 23, 1894	Removing obstructions from Cayuga lake	279	1894	4,000 00	4,000 00	3,200 00	....
Brayer & Albaugh	*Oct. 5, 1894	Protecting berme bank Cayuga and Seneca canal at Geneva	424	1894	15,000 00	13,858 50	11,695 00	....
Hingston & Woods	Aug. 23, 1894	Removing bars and dredging channel of Cayuga inlet	234 656	1892 1894	5,000 00 5,000 00	5,000 00	4,250 00	....
Edward S. Candee	Sept. 27, 1894	Repairs to Madison and Lebanon feeders	570	1894	10,000 00	9,924 44	7,608 70	....
MacGregor & Hughes	Sept. 25, 1893	Improving Oak Orchard and Oak Orchard feeder	186	1893	35,000 00	30,900 00	29,000 00	18,360 00
A. F. Chapman	Aug. 3, 1894	Ditching and rebuilding culverts for abating the nuisances on Chemung canal, on the lands of General Divens and others, between lock 48 and Grand Central avenue, Elmira, N. Y	726 358	1893 1894	....	....	4,203 60	1,173 00

A. F. Chapman	July 23, 1894	Abatement of nuisances on Chemung canal, between Horseheads and Pine Valley, and at lock 26, Millport, on the Chemung canal feeder at East Corning, on the lands of Haight, Goff & Gillett	726 358	1893 1894	....	....	4,428 90	3,604 00
A. F. Chapman	July 23, 1894	Abatement of nuisances on Chemung canal, at the culvert between locks Nos 1 and 2, at lock No. 2, and at Falls creek, Havana, N. Y.	726 358	1893 1894	....	....	893 40	374 00
John Coughlin	July 24, 1894	Vertical wall laid in cement to protect east bank of Falls creek, Havana, N. Y.	345	1894	5,000 00	3,700 00	1,803 00	953 00
Hingston & Woods	July 23, 1894	Improving and dredging Erie basin, in the city of Buffalo, N. Y.	588	1894	2,925 00	2,527 00	1,998 00	None.

* City of Utica appropriated $15,000 of this sum.

REPORT

OF THE

DIVISION ENGINEER

OF THE

EASTERN DIVISION

FOR THE

YEAR ENDING SEPTEMBER 30, 1894.

APPENDIX B.

ALBANY, N. Y., *October* 1, 1894.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor:*

SIR.— I have the honor to submit the following report on the eastern division of the New York State canals, for the fiscal year ending September 30, 1894:

DESCRIPTION OF THE EASTERN DIVISION.

This division embraces that portion of the Erie canal, with its feeders and side-cuts, extending from the Hudson river at Albany to the dividing line between the counties of Herkimer and Oneida, and the whole of the Champlain canal, with its feeders, ponds and side-cuts. For convenience of maintenance and operation it is subdivided into repair sections as follows:

Section No. 1, Erie, extends from the Hudson river to the head of lower Mohawk aqueduct, including the Albany basin and the side-cuts at Port Schuyler and West Troy, and also includes that portion of the Champlain canal extending from its junction with the Erie to the northerly end of the bridge across the Mohawk river and the dam at Cohoes.

Section No. 2, Erie, extends from the head of lower Mohawk aqueduct to the head of lock No. 27.

Section No. 3, Erie, extends from the head of lock No. 27 to the head of lock No. 34.

Section No. 4, Erie, extends from the head of lock No. 34 to the westerly end of the division.

Section No. 1, Champlain, extends from the northerly end of the Mohawk river bridge at Cohoes, to the north end of bridge across the Hudson river at Northumberland, including sloop-lock and pond at Troy.

Section No. 2, Champlain, extends from the north end of bridge across the Hudson river at Northumberland, to the waste-weir at Dunham's Basin.

Section No. 3, Champlain, extends from the waste-weir at Dunham's Basin to Lake Champlain.

The mileage of canals, feeders and river improvements is as follows:

NAVIGABLE.

	Miles
Erie canal, Albany, to east line of Oneida county......	106.243
Port Schuyler and West Troy side-cuts	.350
Albany basin	.770
Champlain canal, including Waterford side-cuts and Cohoes and Saratoga dams	66.000
Pond above Troy dam	3.000
Glens Falls feeder and pond	12.000
Total	188.363

FEEDERS NOT NAVIGABLE.

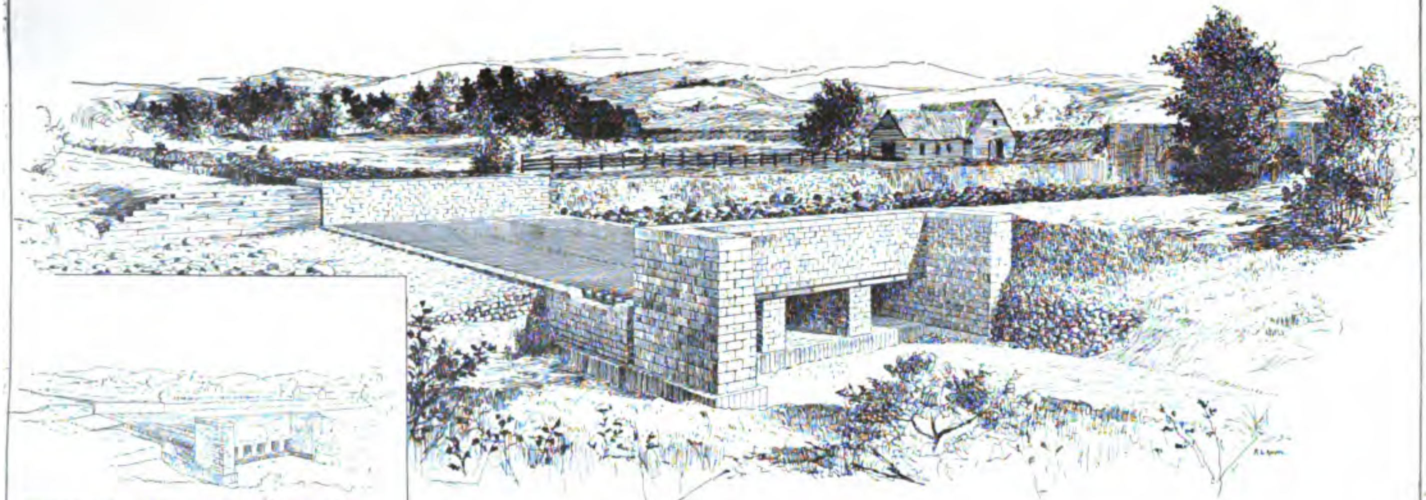
	Miles.
Mohawk river, at Rexford Flats	.39
Mohawk river, south side, at Little Falls	.19
Mohawk river, at Rocky Rift	3.92
Schoharie creek	.63
Total	5.13

ERIE CANAL — WATER SUPPLY.

The Erie canal upon this division is supplied with water from the following sources:

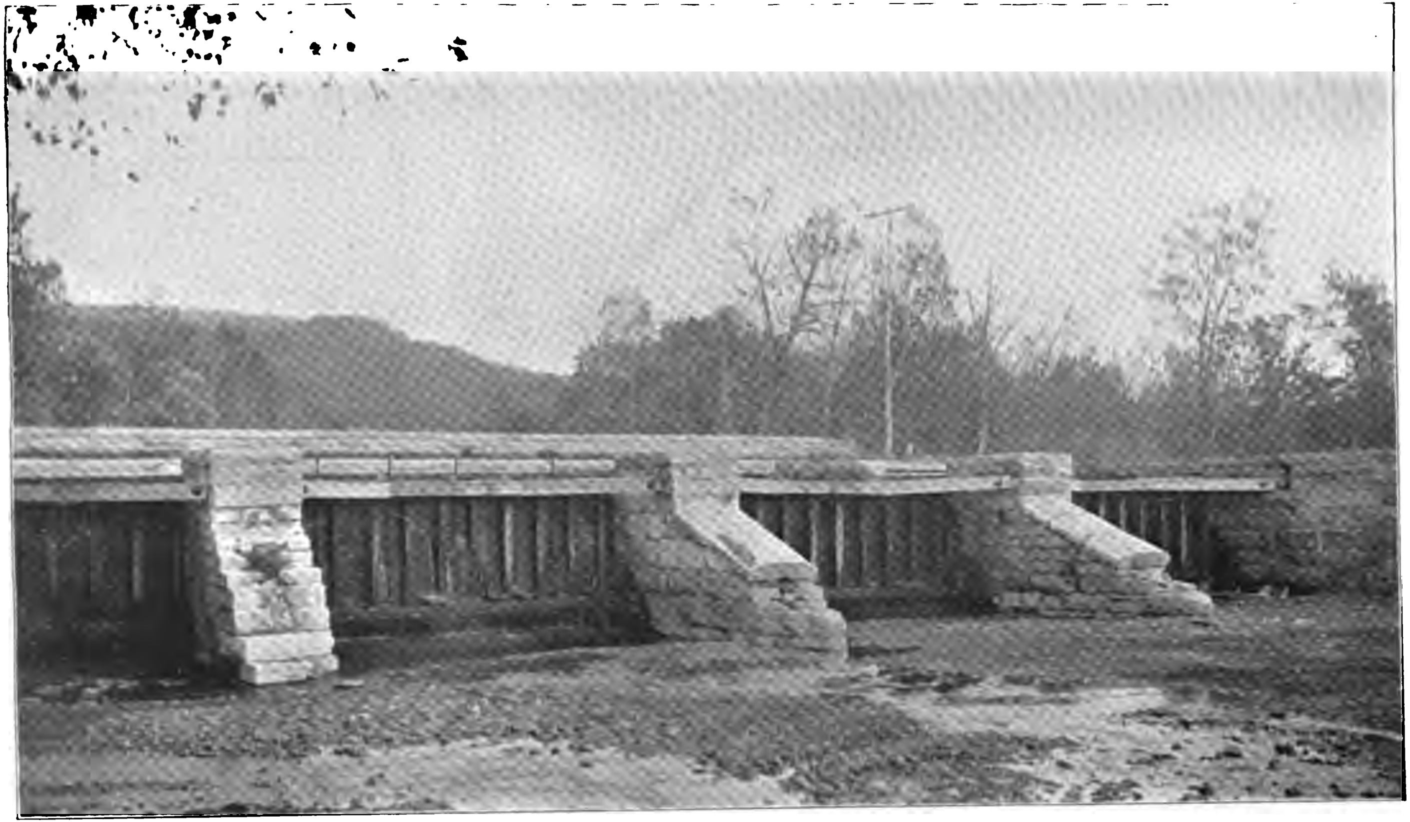
That portion of this division west of Little Falls is supplied from reservoirs and streams on the middle division, through the Rome level. At Little Falls the supply is through the feeder from the Mohawk river, entering the canal through the towpath about 60 feet below lock No. 39.

Near Mindenville the supply is through the Rocky Rift feeder from the Mohawk river, discharging into the canal through the towpath, 400 feet below lock No. 34.

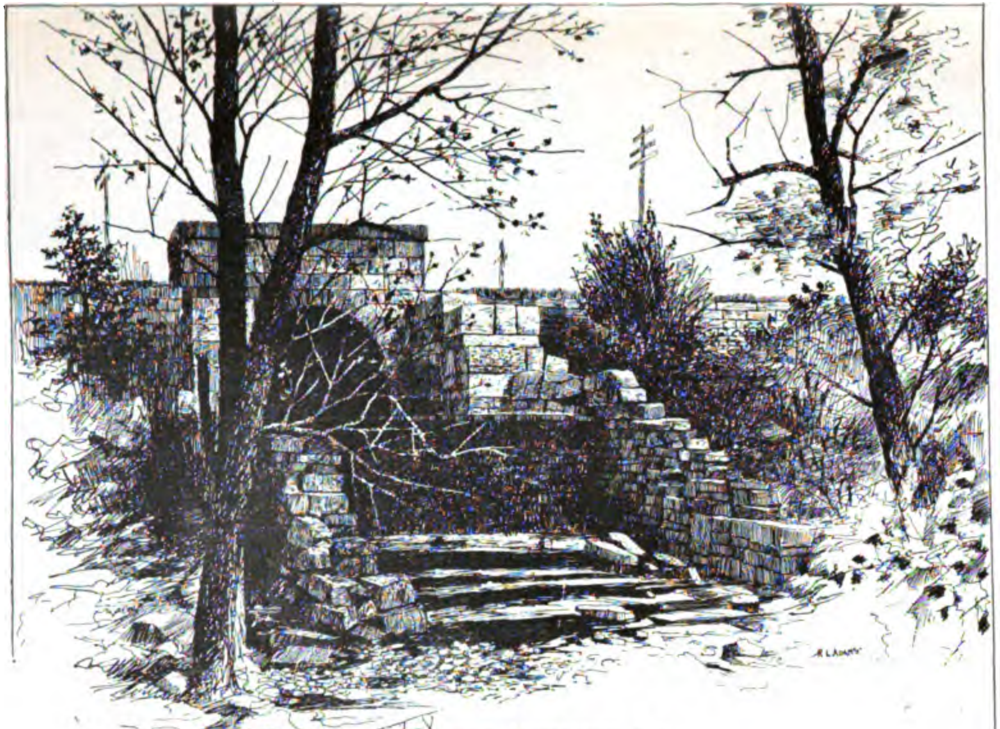


OLD CULVERT OF SIX OPENINGS WITH WATERWAY OF 96 SQ. FT.
THE NEW CULVERT HAS THREE OPENINGS WITH WATERWAY OF 209 SQ. FT.

SKETCH SHOWING REBUILT CULVERT CONVEYING WATERS OF
ROCKY RIFT FEEDER UNDER INDIAN CASTLE CREEK

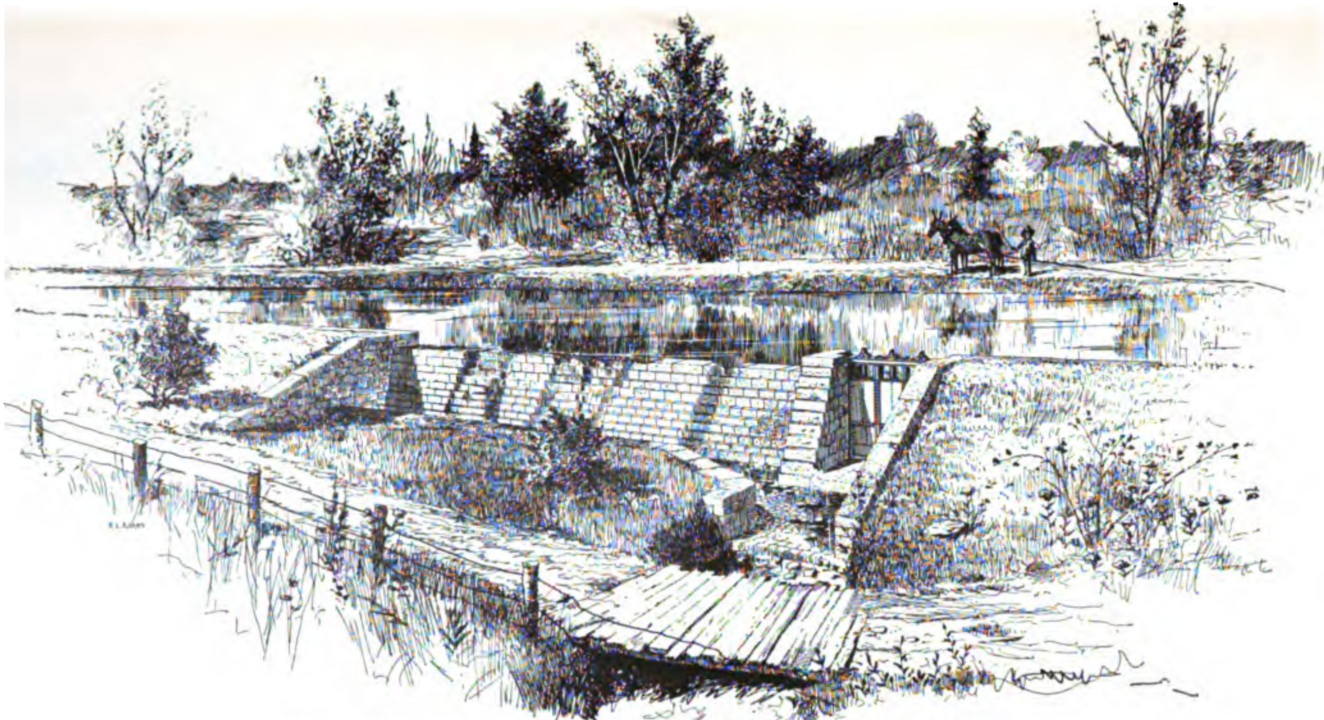


SANSAI KILL AQUEDUCT.

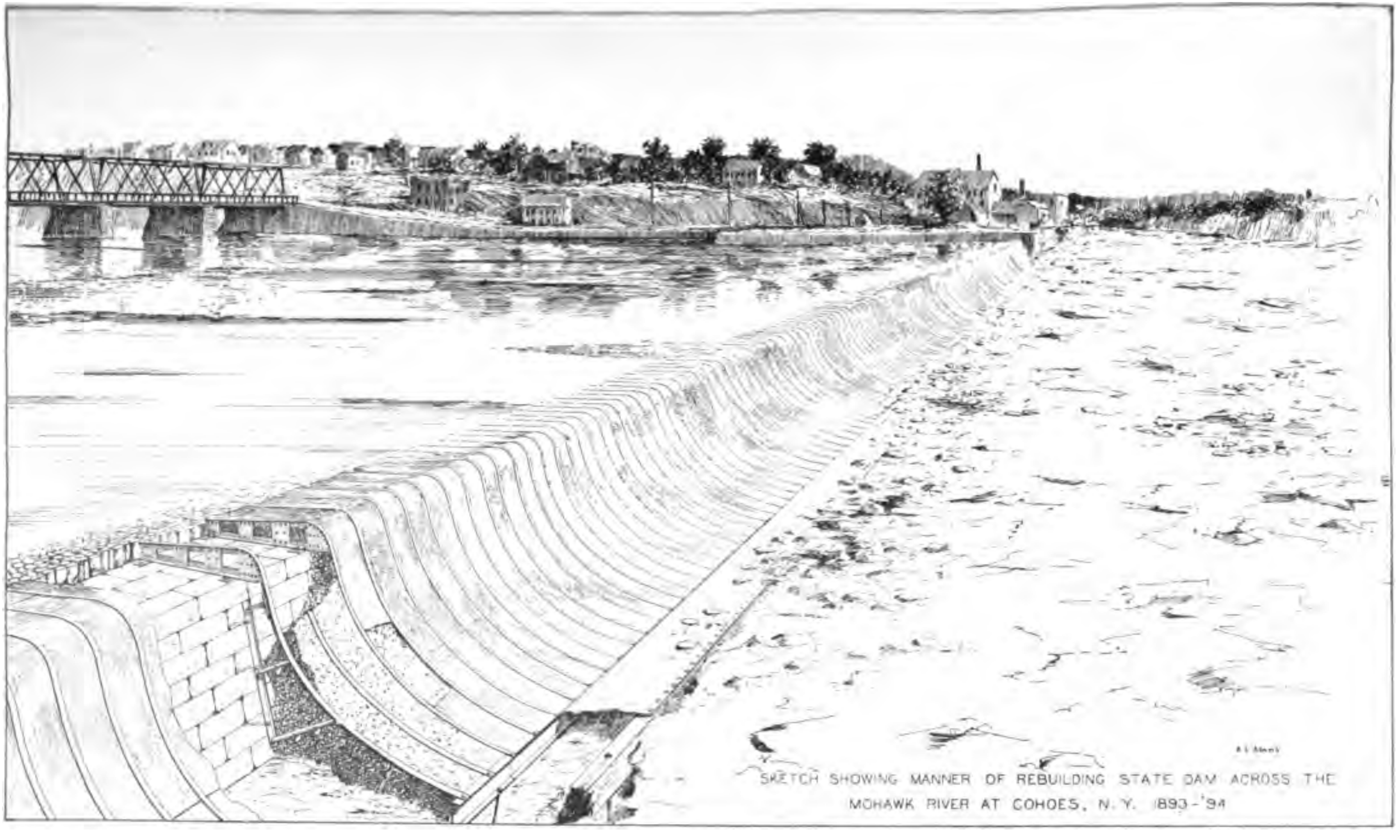


DILAPIDATED WASTE WEIR NEAR SCHENECTADY, N.Y.

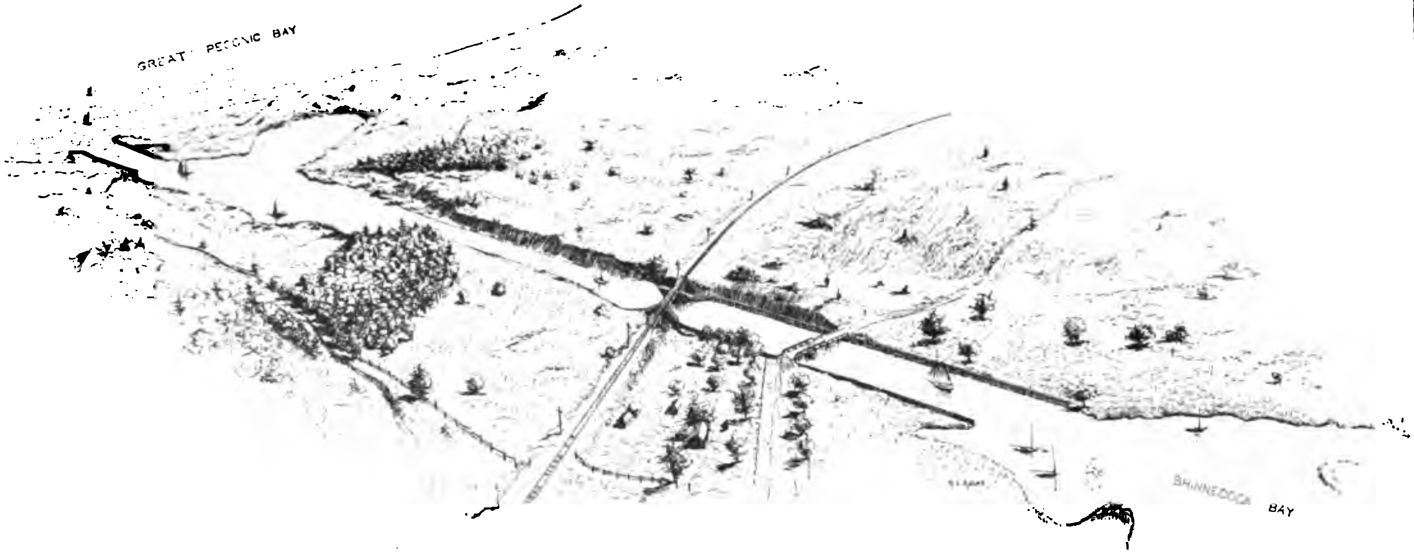
FROM A PHOTOGRAPH



PROPOSED NEW WASTE WEIR WITH STEEL BULKHEAD AT FORT HERKIMER, N.Y.

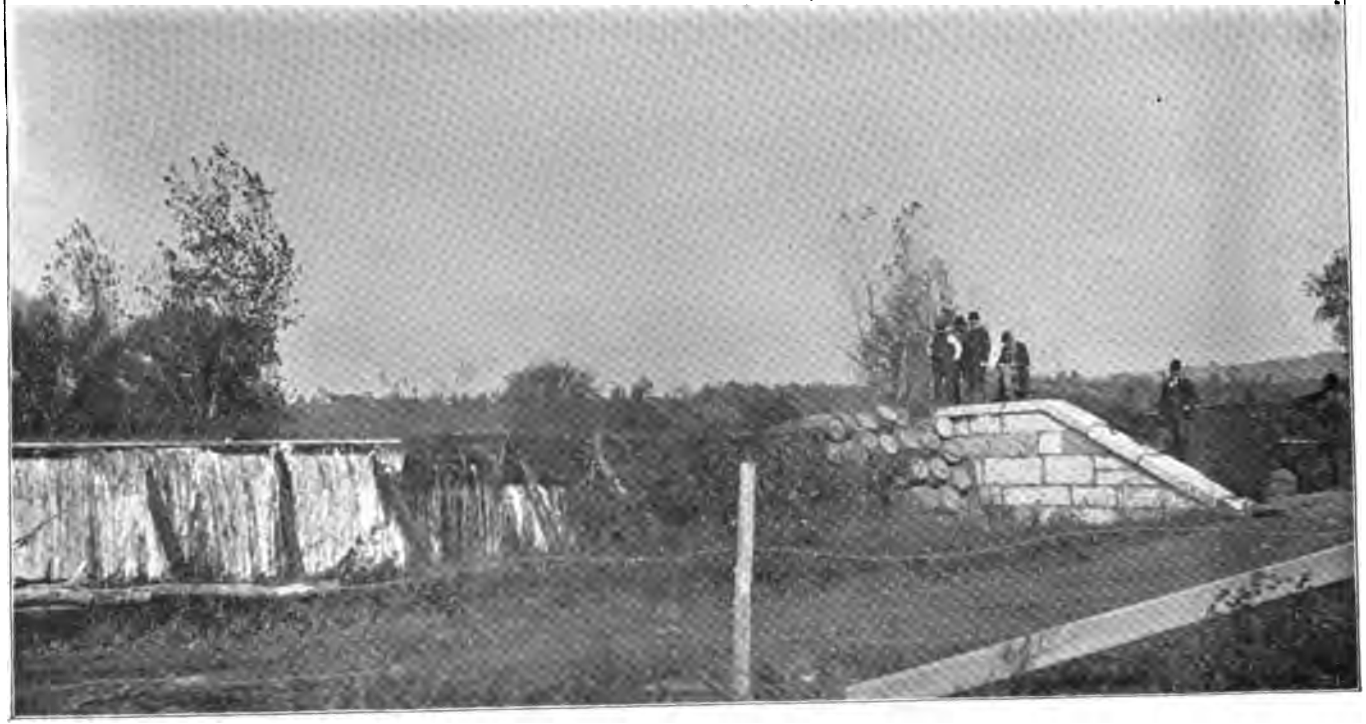


SKETCH SHOWING MANNER OF REBUILDING STATE DAM ACROSS THE
MOHAWK RIVER AT COHOES, N. Y. 1893-'94



SHINNECOCK AND PECONIC CANAL LONG ISLAND, N.Y.

AURIESVILLE AQUEDUCT.



FORT HERKIMER WASTE WEIR, NEAR LOCK 41.

Near Fort Hunter the supply is from Schoharie creek, discharging into the canal on the berme side about 400 feet below lock No. 29.

At Rexford Flats the supply is from the Mohawk river, entering the canal through the towpath, about 120 feet below lock No. 21.

The water supply on this division of the Erie canal has been uniformly good, and the levels kept fully up to their proper elevation.

CHAMPLAIN CANAL — WATER SUPPLY.

The water supply of the Champlain canal is principally from the Hudson river through the Glens Falls feeder, discharging into the summit level of the Champlain canal, supplying the canal from Northumberland to Whitehall, being supplemented on the north by waters of Wood creek. Also from Northumberland to the first lock north of Waterford the supply is from the Hudson river, entering the canal at Northumberland, and from the first lock north of Waterford to its junction with the Erie canal, including the Waterford side-cut, the supply is from the Mohawk river, entering the canal at Cohoes and at its junction with the Erie canal through the Erie canal from Rexford Flats. The water supply on this canal during the past year has been ample.

ERIE CANAL.

Banks and Prisms.

The towing-path is in very fair condition, it has been raised with gravel in many places during the past season, but much more of this work is required. Some repairs are needed to the vertical walls in the upper West Troy side-cut. The entrance to the old abandoned lumber slip should be closed with a stone wall in place of the dilapidated coffer-dam, which is liable to fail at any time. A bulkhead should be placed at the entrance to the Mohawk basin to facilitate filling the canal in the spring and also as a protection to the river lock should any leaks occur or accident happen to the gates. It requires from two to three days to fill the basin when the water is being let into the canal

from the Rexford Flats feeder; if the basin were closed with a bulkhead, navigation might be resumed just so much earlier and the basin allowed to fill up gradually after the boats are running.

The vertical walls through the city of Cohoes need rebuilding. These walls were originally built of shaly bluestone, which have disintegrated and fallen into the canal, leaving no support for the docking, and the banks are being rapidly washed away.

About 100 feet of the berme wall, west of Union street bridge in the city of Schenectady, fell into the canal this season, carrying with it the retaining wall which supports the street above. This should be rebuilt before the opening of navigation next season.

The old plank docking along the high banks of the berme side, just west of Schenectady, has been replaced by a stone wall laid in cement. This much-needed improvement, begun four years ago, was completed last spring. The opposite or towing-path bank, where the old plank docking is badly decayed, should be similarly protected.

The old timber docking along the towing-path bank, near the Big Nose, is in very bad condition and should be rebuilt without delay as some serious leaks occurred there during the past season. Some of the vertical wall on the berme side of the canal near the village of Ilion has fallen down and should be rebuilt.

Docking has been repaired at several points along the canal, but there is still a great deal of it which needs renewing.

Locks.

Lock No. 1 leaks very badly through the bottom and is apparently being undermined and new miter-sills are required. This lock has been a source of considerable anxiety for some years past and attempts have been made to repair it but without success, from lack of sufficient appropriation to construct the necessary coffer-dams. The condition now is such that repairs can not be delayed much longer if the structure is to be saved. A substantial coffer-dam should be built across the channel leading into the river, the lock pumped out, the bottom and apron

taken up, the spaces underneath filled with concrete and grout and the whole replanked and new miter-sills inserted.

Locks Nos. 5, 8 9, 12, 13 and 16 all leak through the bottoms and need replanking and the holes underneath the floors filled with concrete and grout.

The temporary repairs to these structures during the past season caused considerable delay to navigation, amounting to three days in the aggregate. The other locks on this division are in very good condition, except that the masonry in nearly all needs repointing. The joints should be thoroughly cleaned out and filled with grout made of Portland cement. Forty-seven new lock-gates and 35 new balance-beams were inserted during the past season.

Lock No. 19 was lengthened last winter and the contract has been let for lengthening lock No. 20 the coming winter.

Only two more locks, Nos. 21 and 22, need lengthening to complete the series of lengthened locks from the "sixteens" to Little Falls. It is hoped that appropriations for lengthening these two locks will soon be granted.

Culverts.

The culverts are generally in good condition, though some need repairs to the wing walls and nearly all need cleaning out.

The culvert which carries the Rocky Rift feeder under Castle creek has been in bad condition for some time and the contract is let for rebuilding it. It is a dive culvert of the box pattern having five piers in the channel which greatly obstruct the flow of water. The old coping is to be taken up, three of the piers removed, the masonry of the remaining piers to be carried up two feet and the whole to be covered with a solid iron floor. This will increase the area of water way from 96 square feet to 210 square feet.

Aqueducts.

The upper and lower Mohawk aqueducts and the Schoharie Creek aqueduct have received extensive repairs during the past two years and are now in good condition. The Flat Stone Creek aqueduct, which was carried away in 1892 and was rebuilt of

timber, appears to be safe for the present. The Sansai Kill aqueduct (see opposite page) needs considerable repairs to the masonry, also a new timber trunk and the gravel deposit removed from the bed of the creek, underneath the aqueduct, which almost fills the entire waterway. Some measures should be taken to prevent this deposit of debris underneath these structures, which is of annual occurrence; they are usually cleaned out during the cessation of navigation, but the spring freshets fill them up again. The cause is obvious. In building these structures, in order to obtain sufficient waterway in times of flood, it is necessary to widen the bed of the creek at this point to compensate for the space taken for the structure, the water rushing down the natural channel on reaching this point spreads out, thus reducing the velocity and consequently depositing whatever may be held in suspension. If a channel should be constructed under one of the spans, contracted at the bottom and protected by a slope wall, and baffle walls placed in front of the remaining spans at a proper distance from them, so as to confine the water to this channel, it would produce a scour that would tend to keep it clean. In cases of extreme flood the water would flow over the baffle walls and under the entire structure, but as the gravel, etc., which is being carried down, would naturally follow the deeper channel, that which flows over the walls would contain very little matter which would be deposited, or dams might be built across the creek some distance above the aqueduct, where they would form ponds of considerable size. Most of the debris would be deposited in these ponds which might easily be removed with teams and scrapers at a fraction of the cost of removing it from underneath the structure.

The above recommendations will apply to nearly all the small aqueducts, as their condition, so far as deposits are concerned, are very similar to those shown in cut on opposite page. The Fort Plain aqueduct needs quite extensive repairs as has been recommended in previous reports; some of the piers should be rebuilt, and the east abutment should be partially rebuilt.

The masonry wings on the berme side of the one-span aqueduct at Furgeson's creek need rebuilding; there are some very

bad leaks through this structure which require immediate attention.

The other aqueducts are in very good condition but all need cleaning out.

Waste-weirs.

Waste-weir No. 7, near lock No. 20, should be rebuilt; it is in a very dilapidated condition and has been closed up for the past three or four years.

Waste-weir No. 8, near Rotterdam street, Schenectady, should be rebuilt; this has also been closed for some years past.

This is a very important structure as it is the only one on the Seven-mile level. The level is composed of high embankments nearly the whole distance and should a leak occur, serious results might happen without some means of quickly drawing off the water. Had it been in working condition during the big flood two years ago, a large portion of the damage might have been averted.

Waste-weir No. 18, near lock No. 41, is in a very dangerous condition; the water has undermined it and it is toppling over; the bulkhead is gone, and its place filled with old barrels of cement. It was with difficulty that navigation was maintained on that level during the past season. It is important that this should be rebuilt at once, and should be the subject of a special appropriation at the earliest possible date.

I would recommend that an appropriation of $25,000 be granted for repairs to aqueducts Nos. 4, 11 and 16, and waste-weirs Nos. 7, 8 and 18.

Dams.

There are four dams on this division of the Erie canal. Dam No. 1 is a stone-masonry dam, located at Rexford Flats across the Mohawk river. The apron of this dam has been carried away, excepting a few feet near the northerly end. A new apron should be rebuilt at once as the dam rests upon shaley bluestone rock which will rapidly wear away by the action of the ice and water and will soon undermine the whole structure.

Dam No. 2, the Schoharie Creek dam, is a timber structure across the Schoharie creek at Fort Hunter. About 75 feet of

this dam at the west end was carried away last spring and has been rebuilt during the summer and repairs made to the remaining portion. The dam is now in good condition. A new bulkhead should be placed at the entrance to the feeder.

Dam No. 3, Rócky Rift, is a stone-masonry dam across the Mohawk river at Indian Castle. This dam is in good condition, but it is too low. If it were raised one foot it would furnish a much larger supply of water and thus require less to be drawn from the levels above lock No. 34, which are supplied through the Little Falls feeder. The bulkhead should be rearranged so as to admit a larger screen; the present one, which is placed in front of the bulkhead gates to keep out the debris which is carried down by the current, frequently clogs up, thus shutting off the supply of water.

Dam No. 4, located at Little Falls across the Mohawk river. This is a new stone dam, built in 1892. The old decayed wooden swing-gates at the bulkhead should be replaced by drop-gates.

Bridges.

Seven wooden bridges have been rebuilt during the past year: Nos. 5, 8, 30, 32, 69, 127 and 135. Renewing wooden bridges forms quite an item in the maintenance account of the canals. Their extreme life is about 12 years, and they are not considered safe after eight years of service. At the present prices of iron and steel, bridges can be built of these materials almost as cheaply as of wood. A few light iron farm-bridges were built in 1878, and are apparently in as good condition as when erected. They are certainly good for a period three or four times as long as the safe limit of wooden structures.

The old Whipple cast-iron arch bridge at Bridge street, Amsterdam, and Ann street, Little Falls, have been replaced by substantial wrought-iron structures.

No. 3, Ferry street lift-bridge. One of the cables broke letting the counterweight box fall on the floor below, doing considerable damage to the structure and severely injuring an employe. This is one of the first lift-bridges built on the canal having a separate

counterweight box for each cable. These weights are always a source of danger to the people passing over the bridge and to the structure itself. They should be replaced by continuous wrought-iron boxes, similar to those in use on the other lift-bridges.

No. 26, at High street, in the city of Cohoes. This bridge is in very bad condition. It is a cast-iron trapezodial truss with wrought-iron link chords and wooden needle-beams, the latter being very much decayed, and the whole floor system is out of adjustment. It is on the main thoroughfare to the New York Central railroad and is subjected to very heavy traffic. It is not safe and should be replaced by a new wrought-iron structure.

No. 60, at State street, Schenectady, needs new sidewalks. This bridge was originally built in 1862; the roadway was rebuilt in 1891, by the Schenectady Street Railroad Company, and the old sidewalks were attached to the new bridge. They are 14 feet wide, and their location is such that dense crowds are liable to congregate upon them. The lower members are badly corroded, some of the chords being nearly eaten away. These sidewalks should be rebuilt at once.

No. 109, wooden farm-bridge, needs rebuilding. Many of the bridges need painting, particularly the iron bridges, most of which have been sadly neglected.

Navigation.

There have been no breaches on this division of the Erie canal during the season.

The standard depth of water has been maintained, and the only delays to navigation were caused by sunken boats, the repairs to the locks mentioned above, and a leak on the Seven-mile level, west of Schenectady. When the water was let into the canal last spring, quite a serious leak occurred over the culvert at Myers' farm. The water was drawn off and the fissure filled with concrete and gravel. The repairs were finished nearly as soon as the boats coming from below reached this level, so it caused only a few hours' delay to navigation.

EXTRAORDINARY REPAIRS — SCHENECTADY WALL.

Chapter 24, *Laws of* 1894.

This act appropriates $35,000 for building 4,150 lineal feet of vertical wall for protecting the embankment of the Erie canal on the berme side, west of the city of Schenectady.

The contract was let to the Troy Public Works Company, March 8, 1894, and the work was completed in time for the opening of navigation, May 1, 1894.

LENGTHENING LOCK NO. 20.

Chapter 572, *Laws of* 1894.

This act appropriates $40,000 for lengthening lock No. 20. Plans have been prepared for lengthening the berme lock at the foot, and the contract was awarded to John Twomey, of Schenectady, July 24. The contractor is now delivering the materials.

The contract for furnishing the machinery for drawing boats into the lock was awarded to W. B. Wemple Sons.

IMPROVEMENT OF ROCKY RIFT FEEDER.

Chapter 655, *Laws of* 1894.

This act provides for rebuilding the culvert under Castle creek and improving the feeder, at an expense not to exceed $8,000. Plans have been prepared and the contract awarded to the Troy Public Works Company, August 25, 1894.

LIFT-BRIDGE AT CANAJOHARIE.

Chapter 592, *Laws of* 1894.

This act appropriates $9,000 for building a lift-bridge across the Erie canal at Canajoharie. No plans have been prepared — appropriation insufficient.

CHAMPLAIN CANAL.

Banks and Prisms.

The improved portion of the Champlain canal has been reconstructed to a standard section of 44 feet width at bottom and six feet depth below the level of the water surface; is in good condition. The improvements that have been made for

several years past have been done in places where the condition of the canal was such as to admit of no further neglect; therefore, they are not continuous, as will be seen from the profile of the Champlain canal accompanying this volume. When the work now under way is completed, there will be 28 1-2 miles of standard section.

Much of the unimproved portion requires repairs to keep the canal in navigable condition much greater than can be accomplished from the ordinary repair fund.

The towing-path is low — in many places only a few inches above water surface, and frequent overflows occur. The water is constantly encroaching upon the banks, narrowing the towing-path so that teams are unable to pass. The prism is so filled up with the materials washed down from the high banks on the berme side that in many places boats are unable to pass, and boats with ordinary loads frequently drag on the bottom. Considerable dredging has been done, which only partially remedied the difficulty. As the loads which boats can carry are governed by that portion of the canal having the least depth of water, the improvements already made will not be productive of the full amount of benefits until the standard depth is attained the entire length of the canal. If the work is to be continued with small appropriations, as heretofore, it will be necessary to follow the practice of reconstructing those portions which are in the worst condition. But, if appropriations sufficient to complete the enlargement in a short period be granted, it would be advisable that the improvements be made continuous from the southerly end of the canal.

Locks.

There are 18 lift-locks and five guard-locks on the Champlain canal. Two of the guard-locks are at the Mohawk river at Cohoes; two at the Hudson river at Northumberland, and one near the Wood Creek feeder dam. There are also three lift-locks combined, on the Waterford side-cut. These are all single locks with chambers 110 by 18 feet; the same capacity as the locks on the Erie canal.

All the locks, excepting three, are in fair condition, though the masonry in many of them need repointing.

Six new lock gates and nine balance-beams have been inserted during the season.

At locks Nos. 6 and 9, the masonry has been forced in toward the chamber, making it impossible for the larger Erie boats to pass through the locks, and it has been found necessary, for several years past, at the close of navigation, to brace the walls apart with timbers. The trouble is probably caused by leakage through the masonry which keeps the embankment back of the walls saturated with water, which freezes in the winter time, both in the walls and behind them, thus tending to force them out.

The difficulty could be remedied by cutting the faces of the walls back to give the chambers the proper dimensions and excavate back of the walls down to the foundations and fill in with a backing of concrete, which should be carried up to the surface and the whole structure thoroughly grouted.

At lock No. 23, the walls have bulged in toward the chamber and are so much out of shape that it will have to be rebuilt.

Waste-weirs and Spillways.

There are 28 waste-weirs and spillways on the Champlain canal and Glens Falls feeder. The following need rebuilding:

Mechanicville, Stillwater, Wilbur's Basin and the one near Finch and Pruyn's limekiln on the Glens Falls feeder. These are all important structures and are in very dangerous condition. They are in such an advanced stage of dilapidation that they can not be repaired.

Mechanicville waste-weir is located between locks Nos. 8 and 9, just north of the village of Mechanicville. The masonry has been forced out of shape and the structure is only held in place by a quantity of riprap piled against the face. The timbers are decayed and the masonry joints are open so as to allow the water to leak through; it has been repeatedly repaired, but it can only be put in safe condition by rebuilding.

Lansing's waste-weir, located at Stillwater. The condition of this structure is similar to the above. Plans are being prepared for rebuilding it the coming winter.

Wilbur's Basin waste-weir. Leaks under the foundation undermined this structure two years ago and it has since been closed up by driving sheet-piling in front of it. This waste-weir should be rebuilt at once. It is located on the Sixteen-mile level, which has several large creeks discharging into it, and the heavy rains are liable to do serious damage without some means of allowing the water to escape.

The Glens Falls feeder waste-weir required constant attention during the past season to prevent its being carried away. It is partially closed with gravel and sheet-piling.

The woodwork of the Manville, Dunham's Basin and Smith's Basin waste-weirs requires renewal before the opening of navigation next season.

Culverts.

The culverts are generally in fair condition, though some of them are partially filled with deposits which contract the openings to such an extent as to render them almost useless. They should be cleaned out.

Watkins culvert, at Whitehall, should be rebuilt; it leaks badly, and the foundation is being undermined.

Dams.

There are seven dams on the Champlain canal, and one on the Glens Falls feeder.

Dam No. 1 is located across the Hudson river at Troy. It is a stone-filled timber-crib dam with apron of similar construction. This dam has received considerable repairing but is still in very poor condition; the timbers are badly decayed and it will soon have to be rebuilt. In the spring of 1893, about 100 feet of the apron was carried away by the ice, and a freshet in the month of June, the same year, carried away about 60 feet of the dam itself. The break was repaired by dropping cribs filled with stone into the opening. The work was done very successfully, but repairs made under such unfavorable circumstances can only serve temporarily.

Dam No. 2 is located across the Mohawk river at Cohoes. This dam has been extensively repaired during the past two years and is now in first-class condition. The breaches in the

masonry have been relaid and the structure strengthened by a new apron of steel, filled underneath with concrete.

Dam No. 3 is located at Northumberland across the Hudson river.

Dam No. 4. is located near Fort Ann, across Wood creek.

Dame Nos. 5, 6 and 7, are located on Wood creek, between locks 19 and 20.

Dam No. 8 is located at the head of the Glens Falls feeder, two miles west of Glens Falls.

Bridges.

Bridges Ncs. 19 and 20 have been replaced with two iron structures.

Bridges Nos. 15, 28, 41, 43, 54, 60, 121 1-2, 122, 123, 124 and 125 have been rebuilt during the past season.

The following bridges need rebuilding: Nos. 10, 16, 48, 58, 65, 85, 86 and 89, Champlain canal, and bridges Nos. 2 and 11, Glens Falls feeder.

EXTRAORDINARY REPAIRS.

Repairing dam across the Mohawk river at Cohoes, chapter 643, Laws of 1893, and chapter 462, Laws of 1894.

The first act appropriates $90,000 and the second act an additional sum of $20,000. The contract was awarded to Cunningham & Monty, of Sandy Hill. The work was completed September 24, 1894.

IMPROVING THE CHAMPLAIN CANAL.

Chapter 119, *Laws of* 1893.

This act appropriates $50,000 for widening and deepening the Champlain canal. Plans were prepared for improving 6,500 lineal feet from Wilbur's Basin waste-weir southerly. The contract was awarded to the Troy Public Works Company of Troy. The work was completed in time for the opening of navigation in 1894.

FITZGERALD BRIDGE.

Chapter 569, *Laws of* 1893.

This act appropriated $4,000 for replacing bridge No. 15 with a wider and more substantial structure and repairing the approaches thereto. The contract was awarded to Cunningham & Monty, and was completed May 15, 1893.

VANDERWERKEN BRIDGE.

Chapter 294, *Laws of* 1893.

This act appropriates $3,500 for improving the approaches to the Vanderwerken bridge. The contract was awarded to the Troy Public Works Company. The work was completed December 29, 1893.

IMPROVING GLENS FALLS FEEDER.

Chapter 278, *Laws of* 1894.

This act appropriates $15,000 for building 1,200 feet of vertical wall along the towing-path bank of the Glens Falls feeder. The contract was awarded to Flood & Sherrill, of Sandy Hill.

IMPROVING THE CHAMPLAIN CANAL.

Chapter 572, *Laws of* 1894.

This act appropriates $56,000 for widening and deepening the Champlain canal. Plans have been prepared for improving 5,200 lineal feet of the canal from Bemis Heights waste-weir northerly, and rebuilding bridges Nos. 39 and 40; also for improving 275 lineal feet from Lansing's waste-wier northerly and rebuilding said waste-weir.

NORTH STREET BRIDGE, MECHANICVILLE.

Chapter 594, *Laws of* 1894.

This act appropriates $8,000 for replacing the light, wooden bridge No. 22, at North street, Mechanicville, with an iron structure, and rebuilding the abutments and approaches thereto.

Plans have been prepared.

SHINNECOCK AND PECONIC CANAL.

Chapter 358, Laws of 1894, appropriates $3,500 for restoring and protecting the approaches to the swing-bridge over the Shinnecock and Peconic canal, and chapter 768, Laws of 1894, appropriates $15,000 for protecting the banks of the Shinnecock and Peconic canal.

Plans have been prepared and the contract was awarded to P. J. Brummelkamp, of Syracuse. The work is now under way.

The canal, which connects the Shinnecock and Peconic bays, was excavated through light loose sand and the currents constantly encroach upon the banks, washing the sand down into the channel. The substructure of the swing-bridge formed such a barrier in the stream that the waters were forced outside of the abutments, carrying away the approaches. The improvement consists of adding a span to the bridge, thus giving the full width of waterway at that point, and driving rows of sheet-piling along either side of the canal to make the channel of uniform width from Shinnecock bay to the Long Island Railroad Company's bridge. The abutments of this structure narrow the channel and forms an obstruction which greatly increases the velocity of the current at that point. The foundations are being undermined and they are in a very dangerous condition. When the tides are changing, during severe storms, these obstructions form cross-currents which tend to produce a scour into the shifting sands, causing changes in the courses of the channel. The abutments should be set back and the rows of sheet-piling continued as far as Conkling pond, thus giving a uniform width of channel the entire length of the canal.

MOLE AT HOUGHTALING ISLAND.

Chapter 358, *Laws of* 1894.

This act appropriates $1,200 for building a roadway from the State dyke along Houghtaling island to connect with the island. The contract was awarded to William Fuller, of New Baltimore. The work is now under way.

The State dykes in the Hudson river, extending from Albany to New Baltimore, need considerable repairing. The piles are broken in many places, allowing the stone filling back of them to fall into the channel. These breaks are caused by boats striking against the dykes and by the action of the ice during freshets.

Repairs should be made at once to save the remaining portions of the dykes and prevent obstructions to navigation. I would recommend that an appropriation of $10,000 be granted for that purpose.

BOARD OF CLAIMS.

Much work has been done for the Attorney-General in making surveys and maps and giving expert testimony in defending actions brought against the State before the Board of Claims. These claims for damages embrace quite a wide extent of territory, and some of them require quite extensive surveys; for instance, the claims for damages from overflow of Wood creek, requiring the location and elevation of the several pieces of property bordering on either side of the creek for a distance of 17 miles.

The Cowasselon swamp claims extend 16 miles. The total number of claims for which surveys have been made during the past season is 137.

It has required quite a large force to make these surveys and their wide distribution make the expenses for traveling somewhat heavy. Many photographs have been taken which, in connection with the maps, are of great service to the board. This work has been in charge of Mr. T. C. Leutze and has been managed as economically as is consistent with accurate results. When the sums claimed are compared with the amounts awarded the value of the work is quite apparent.

This division has been under the charge of Mr. John P. Kelly, as division engineer, from September 30, 1893, to January 10, 1894; Mr. Herschel Roberts, from January 10, 1894, to July 17, 1894 and Mr. DeWitt C. Smith, from July 17, 1894, to September 30, 1894; with Mr. Jay W. Clark as resident engineer from September 30, 1893, to March 1, 1894; Mr. DeWitt C. Smith from March 1, 1894, to July 17, 1894, and Mr. Albert J. Himes from July 17, 1894, to September 30, 1894.

A statement of the engineering expenses of this division is hereto annexed, showing in detail the names of the persons employed, time of service and compensation of each; also a statement showing the contracts completed and final accounts rendered during the year and contracts finished on the 30th day of September, 1894.

Respectfully submitted,

DEWITT C. SMITH,
Division Engineer.

Statement showing names, rank, number of days and compensation of Engineers employed on the Eastern Division of the New York State Canals, together with incidental expenses during the fiscal year ending September 30, 1894.

ORDINARY REPAIRS — ERIE CANAL.— *Chapter* 89, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John P. Kelly	Division engineer	....	$2,400 00 per year	$465 75	$20 94	$486 69
Herschel Roberts	Division engineer	....	2,400 00 per year	800 90	59 51	860 41
DeWitt C. Smith	Division engineer	....	2,400 00 per year	230 08	37 12	267 20
Jay W. Clark	Resident engineer	....	2,000 00 per year	387 69	129 70	517 39
DeWitt C. Smith	Resident engineer	....	2,000 00 per year	142 74	61 98	204 72
Albert J. Himes	Resident engineer	....	2,000 00 per year	81 45	6 40	87 85
H. C. Landon	Assistant engineer in charge	68	6 00 per day	408 00	9 86	417 86
T. C. Leutze	Assistant engineer in charge	119	6 00 per day	714 00	135 79	849 79
Charles G. Witbeck	Assistant engineer in charge	28	6 00 per day	168 00	....	168 00
John R. Kaley	Assistant engineer in charge	2	6 00 per day	12 00	4 35	16 35
Thomas A. Patterson	Leveler	53	4 50 per day	238 50	36 61	275 11
C. S. Haynes	Leveler	48	4 50 per day	216 00	5 46	221 46
Dorlon Clark	Leveler	32	4 50 per day	144 00	75	144 75
William J. Smith	Rodman	62	3 50 per day	217 00	33 83	250 83
C. M. Pepson	Rodman	115	3 50 per day	395 50	33 39	428 89
John H. Jones	Rodman	18	3 50 per day	63 00	....	63 00
James Ryan, Jr	Rodman	12	3 50 per day	42 00	....	42 00
A. M. Evans	Rodman	24	3 50 per day	84 00	....	84 00
F. A. Bagg	Rodman	46	3 50 per day	161 00	31 39	192 39
Augustus Nieber	Chainman	54	2 50 per day	135 00	3 20	138 20
T. F. Goggin	Chainman	6	2 50 per day	15 00	....	15 00
F. D. Ryan	Chainman	2	2 50 per day	5 00	....	5 00
Fred. Lewis	Chainman	78	3 50 per day	273 00	2 97	275 97
George R. Mann	Chainman	9	2 50 per day	22 50	....	22 50
B. Fredericks	Chainman	60	2 50 per day	150 00	32 09	182 09
H. J. Richardson	Chainman	79	2 50 per day	197 50	56 83	254 33
L. B. Jones	Chainman	15	2 50 per day	37 50	....	37 50
Chas. Erlenwein	Chainman	13	2 50 per day	32 45	....	32 45
Eugene H. Lilly	Chainman	11	2 50 per day	27 50	....	27 50
Arthur O'Brien	Chainman	26	2 50 per day	65 00	16 74	81 74
Ralph Russell	Chainman	26	2 50 per day	65 00	20 63	85 63
C. A. Cockcroft	Chainman	34	4 50 per day	153 00	....	153 00
John J. Allen	Chainman	83	4 00 per day	332 00	....	332 00
Fred. D. Haak	Chainman	26	2 50 per day	65 00	....	65 00
Fred. D. Haak	Chainman	53	4 00 per day	212 00	....	212
						$7,498 59

Incidental expenses.

Livery	$138 00	
Labor	179 94	
Office rent	56 51	
Draughting	24 89	
Inspection	89 58	
Stationery	756 73	
Postage and telegraph	216 80	
Light and fuel	2 72	
Miscellaneous	485 54	
		1,896 70
		$9,895 29

ORDINARY REPAIRS — CHAMPLAIN CANAL.

Chapter 89, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John P. Kelly	Division engineer	....	$2,400 00 per year	$200 00	$5 40	$205 40
Herschel Roberts	Division engineer	....	2,400 00 per year	333 35	4 50	337 85
DeWitt C. Smith	Division engineer	....	2,400 00 per year	66 67	15 66	82 33
Jay W. Clark	Resident engineer	....	2,(0) 00 per year	88 80	17 25	106 05
T. C. Leutze	Assistant engineer in charge	6	6 00 per day	36 00	2 56	38 56
John R. Kaley	Assistant engineer in charge	7	6 00 per day	42 00	13 59	55 59
Charles G. Witbeck	Assistant engineer in charge	13	6 00 per day	78 00	....	78 00
Thomas A. Patterson	Leveler	52	4 50 per day	234 00	57 90	291 90
William J. Smith	Rodman	51	3 50 per day	178 50	2 20	180 70
John H. Jones	Rodman	16	3 50 per day	56 00	3 84	59 84
A. M. Evans	Rodman	11	3 50 per day	38 50	....	38 50
F. A. Bagg	Rodman	79	3 50 per day	276 50	3 50	280 00
Douglass Cornell	Rodman	56	3 50 per day	196 00	1 91	197 91
John J. Allen	Chainman	183	4 00 per day	732 00	1 35	733 35
Jay Capron	Chainman	8	5 00 per day	40 00	....	40 00
B. Frederick	Chainman	27	2 50 per day	67 50	2 63	70 13
L. B. Jones	Chainman	22	2 50 per day	55 00	....	55 00
Arthur O'Brien	Chainman	53	2 50 per day	132 50	8 85	141 35
Ralph Russell	Chainman	38	2 50 per day	95 00	34 68	129 68
George McDonald	Chainman	26	2 50 per day	65 00	55	65 55
William J. Gilmore	Chainman	40	2 50 per day	100 00	....	100 00
						$3,287 50

Incidental expenses.

Livery	$147 00	
Labor	40 00	
Stationery	174 26	
Postage and telegraph	33 35	
Office rent	13 00	
Miscellaneous	24 66	
		432 77
		$3,719 86

EXTRAORDINARY REPAIRS — REPAIRING DAM AT COHOES.

Chapter 643, *Laws of* 1893, *Chapter* 462, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Jay W. Clark	Resident engineer	....	$3,000 00 per year	$59 73	$6 00	$65 73
DeWitt C. Smith	Resident engineer	....	2,000 00 per year	86 88	....	86 88
Albert J. Himes	Resident engineer	....	2,000 00 per year	43 44	3 10	46 54
John R. Raley	Assistant engineer in charge	100	6 00 per day	600 00	57 00	657 00
Reeves Smith	Assistant engineer	8	5 00 per day	40 00	....	40 00
C. C. Huestis	Assistant engineer	116	5 00 per day	580 00	12 58	592 58
Dorion Clark	Leveler	7	4 50 per day	31 50	....	31 50
Reeves Smith	Leveler	74	4 50 per day	333 00	1 95	334 95
J. C. Dougrey	Rodman	59	3 50 per day	206 50	6 90	213 40
Douglass Cornell	Rodman	34	3 50 per day	119 00	....	119 00
F. J. Lempe	Rodman	115	3 50 per day	402 50	85	403 35
C. M. Pepson	Rodman	27	3 50 per day	94 50	3 00	97 50
Thomas B. Kelly	Chainman	90	2 50 per day	225 00	....	225 00
E. Herlihey	Chainman	7	2 50 per day	17 50	85	18 35
Wm. E. Burk	Chainman	78	2 50 per day	195 00	4 80	199 80
Timothy Quinn	Chainman	26	2 50 per day	65 00	....	65 00
B. Toner	Chainman	109	2 50 per day	272 50	10 85	282 85
L. B. Jones	Chainman	8	2 50 per day	20 00	1 00	21 00
Eugene H. Lilly	Chainman	54	2 50 per day	135 00	2 50	137 50
H. J. Richardson	Chainman	1	2 50 per day	2 50	1 68	4 18
H. F. Smith	Chainman	89	3 50 per day	311 50	2 00	313 50
						$3,955 61
Incidental expenses.						
Labor					$1 25	
Fuel and light					14 65	
Stationery					10 50	
Postage and telegraph					7 95	
Office rent					71 30	
Miscellaneous					8 46	
						114 11
						$4,069 72

EXTRAORDINARY REPAIRS — LITTLE FALLS DAM.

Chapter 480, *Laws of* 1892, *Chapter* 119, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
H. C. Landon	Assistant engineer in charge	1	$6 00 per day	$6 00	$4 98	$10 98
Incidental expenses.						
Postage and telegraph					$0 59	
Miscellaneous					40	
						0 99
						$11 97

EXTRAORDINARY REPAIRS — CHAMPLAIN CANAL.

Chapter 119, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Jay W. Clark	Resident engineer	....	$3,000 00 per year	$71 79	$4 16	$75 95
John R. Kaley	Assistant engineer in charge	84	6 00 per day	504 00	92 02	596 02
F. A. Bagg	Rodman	133	3 50 per day	465 50	24 98	490 48
Douglass Cornell	Rodman	19	3 50 per day	66 50	6 35	72 85
J. C. Dougrey	Rodman	57	3 50 per day	199 50	7 95	207 45
A. M. Evans	Rodman	73	3 50 per day	255 50	16 36	271 86
John A. Sheehan	Chainman	104	2 50 per day	260 00	15 40	275 40
Robert E. Johnson	Chainman	108	2 50 per day	270 00	8 00	278 00
E. Herlihey	Chainman	138	2 50 per day	345 00	19 55	364 55
George McDonald	Chainman	77	2 50 per day	192 50	9 75	202 25
Ralph Russell	Chainman	61	2 50 per day	152 50	11 25	163 75
Arthur O'Brien	Chainman	25	2 50 per day	62 50	8 77	71 27
						$3,069 83
Incidental expenses.						
Fuel and light					$17 25	
Livery					325 75	
Office rent					42 25	
Postage and telegraph					3 81	
Miscellaneous					52 61	
						441 67
						$3,511 50

EXTRAORDINARY REPAIRS — LENGTHENING LOCK NO. 19, ERIE CANAL.

Chapter 119, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
DeWitt C. Smith	Division engineer	....	$2,400 00 per year	$200 00	$8 76	$208 76
DeWitt C. Smith	Resident engineer	....	2,000 00 per year	10 98	3 08	14 06
Jay W. Clark	Resident engineer	....	2,000 00 per year	71 79	26 50	98 29
Albert J. Himes	Resident engineer	....	2,000 00 per year	162 90	17 40	180 30
T. C. Leutze	Assistant engineer in charge	3	6 00 per day	18 00	2 26	20 26
Charles G. Witbeck	Assistant engineer in charge	135	6 00 per day	810 00	60 95	870 95
John B. Kaley	Assistant engineer in charge	17	6 00 per day	102 00	2 50	104 50
Dorlon Clark	Leveler	126	4 50 per day	567 00	7 45	574 45
Claude Haynes	Leveler	2	4 50 per day	9 00	3 80	12 80
T. A. Patterson	Leveler	33	4 50 per day	148 50	11 88	160 38
C. M. Pepson	Rodman	2	3 50 per day	7 00	5 31	12 31
John H. Jones	Rodman	36	3 50 per day	126 00	7 12	133 12
James Ryan, Jr.	Rodman	3	3 50 per day	10 50	5 34	15 84
A. M. Evans	Rodman	28	3 50 per day	98 00	8 95	106 95
George R. Mann	Chainman	3	2 50 per day	7 50	5 34	12 84
B. Frederick	Chainman	3	2 50 per day	7 50	6 09	13 59
R. A. Barrett	Chainman	110	2 50 per day	275 00	3 68	278 68
John Vischer	Chainman	113	2 50 per day	282 50	....	282 50
Wm. J. Gilmore	Chainman	9	2 50 per day	22 50	....	22 50
C. A. Cockcroft	Chainman	28	4 50 per day	126 00	2 39	128 39
Eugene H. Lilly	Chainman	25	2 50 per day	62 50	....	62 50
George McDonald	Chainman	25	2 50 per day	62 50	4 98	67 48
Fred. D. Haak	Chainman	25	4 00 per day	100 00	....	100 00
						$3,481 45
Incidental expenses.						
Office rent					$50 00	
Labor					12 00	
Livery					38 50	
Postage and telegraph					28 85	
Stationery					151 40	
Miscellaneous					240 94	
						521 69
						$4,003 14

EXTRAORDINARY REPAIRS — REPAIRING SCHOHARIE CREEK AND UPPER AND LOWER MOHAWK AQUEDUCTS.

Chapter 5, Laws of 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Jay W. Clark	Resident engineer	....	$2,000 00 per year	$65 76	$42 93	$108 69
T. C. Leutze	Assistant engineer in charge	15	6 00 per day	90 00	18 57	108 57
Dorion Clark	Leveler	20	4 50 per day	90 00	....	90 00
William J. Smith	Rodman	5	3 50 per day	17 50	6 65	24 15
A. M. Evans	Rodman	15	3 50 per day	52 50	2 75	55 25
						$386 66
Incidental expenses.						
Livery						28 00
						$414 66

EXTRAORDINARY REPAIRS — CONSTRUCTION OF BRIDGE AT ANN STREET, LITTLE FALLS, N. Y.

Chapter 197, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
DeWitt C. Smith	Resident engineer	....	$2,000 00 per year	$16 47	$10 38	$26 85
T. C. Leutze	Assistant engineer in charge	2	6 00 per day	12 00	3 96	15 96
H. C. Landon	Assistant engineer in charge	1	6 00 per day	6 00	3 46	9 46
William J. Smith	Rodman	1	3 50 per day	3 50	3 96	7 46
Charles Erlenwein	Chainman	7	2 50 per day	17 50	20 91	38 41
L. B. Jones	Chainman	2	2 50 per day	5 00	....	5 00
George P. Hilton	Draughtsman	....	....	80 43	....	80 43
						$183 57
Incidental expenses.						
Postage and telegraph						82
						$184 39

EXTRAORDINARY REPAIRS — CONSTRUCTION OF BRIDGE AT BRIDGE STREET, AMSTERDAM, N. Y.

Chapter 561, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
T. C. Leutze	Assistant engineer in charge	16	$6 00 per day	$96 00	$15 79	$111 79
Dorlon Clark	Leveler	1	4 50 per day	4 50	2 32	6 82
William J. Smith	Rodman	1	3 50 per day	3 50	2 32	5 82
C M. Pepson	Rodman	1	3 50 per day	3 50	1 82	5 32
H. J. Richardson	Chainman	7	2 50 per day	17 50	10 74	28 24
B. Frederick	Chainman	1	2 50 per day	2 50	2 32	4 82
Charles Erlenwein	Chainman	5	2 50 per day	12 50	8 60	21 10
George P. Hilton	Draughtsman	....	....	131 70	....	131 70
						$315 61

EXTRAORDINARY REPAIRS — CONSTRUCTION OF APPROACHES TO VANDERWERKEN FARM BRIDGE, AT WATERFORD, N. Y.

Chapter 294, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Jay W. Clark	Resident engineer	....	$2,000 00 per year	$27 15	....	$27 15
T. C. Leutze	Assistant engineer in charge	15	6 00 per day	90 00	$5 00	95 00
H. C. Landon	Assistant engineer in charge	2	6 00 per day	12 00	2 20	14 20
William J. Smith	Rodman	16	3 50 per day	56 00	1 10	57 10
C. M. Pepson	Rodman	3	3 50 per day	10 50	4 70	15 20
John H. Jones	Rodman	10	3 50 per day	35 00	....	35 00
B. Frederick	Chainman	15	2 50 per day	37 50	1 25	38 75
B. A Barrett	Chainman	1	2 50 per day	2 50	1 10	3 60
						$286 00

EXTRAORDINARY REPAIRS — CONSTRUCTION OF BRIDGE NO. 15 (FITZGERALD BRIDGE), CHAMPLAIN CANAL.

Chapter 569, Laws of 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Jay W. Clark	Resident engineer	....	$3,000 00 per year	$27 15	....	$27 15
T. C. Leutze	Assistant engineer in charge	33	6 00 per day	198 00	$40 90	238 90
William J. Smith	Rodman	1	3 50 per day	3 50	1 70	5 20
C. M. Pepson	Rodman	1	3 50 per day	3 50	2 20	5 70
B. Frederick	Chainman	2	2 50 per day	5 00	4 28	9 28
R. A. Barrett	Chainman	1	2 50 per day	2 50	1 70	4 20
						$290 43
Incidental expenses.						
Livery					$39 00	
Postage and telegraph					89	
						39 89
						$330 32

EXTRAORDINARY REPAIRS — DREDGING ALBANY BASIN.

Chapter 567, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Jay W. Clark	Resident engineer	...	$2,000 00 per year	$37 15	....	$37 15
Charles G. Witbeck	Assistant engineer in charge	51	6 00 per day	306 00	$6 20	312 20
James Ryan, Jr.	Rodman	49	3 50 per day	171 50	....	171 50
William J. Burk	Chainman	14	2 50 per day	35 00	....	35 00
John A. Sheehan	Chainman	19	2 50 per day	47 50	....	47 50
T. B. Lehaney	Chainman	78	2 50 per day	195 00	....	195 00
						$788 35
Incidental expenses.						
Office rent					$10 00	
Postage and telegraph					48	
Stationery					12 00	
Miscellaneous					36 15	
						58 63
						$846 98

EXTRAORDINARY REPAIRS — IMPROVING SARANAC RIVER.

Chapter 141, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Chapman L. Johnson	Deputy State engineer	....	....	....	$16 75	$16 75
Incidental expenses.						
Labor					$124 00	
Postage and telegraph					68	
						124 68
						$141 43

EXTRAORDINARY REPAIRS — ABATING NUISANCE — CHEMUNG CANAL AND FEEDER.

Chapter 726, Laws of 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Dorlon Clark	Leveler	12	$4 50 per day	$54 00	....	$54 00
Incidental expenses.						
Postage and telegraph						15
						$54 15

EXTRAORDINARY REPAIRS — SHINNECOCK AND PECONIC CANAL.

Chapter 726, Laws of 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Claude Haynes	Leveler	54	$4 50 per day	$243 00	$9 08	$252 08
Incidental expenses.						
Postage and telegraph					$2 76	
Miscellaneous					9 35	
						12 11
						$264 19

EXTRAORDINARY REPAIRS — STRENGTHENING AND PROTECTING BERME BANK, ERIE CANAL, NEAR SCHENECTADY, N. Y.

Chapter 24, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
DeWitt C. Smith	Resident engineer	....	$3,000 00 per year	$490 47	$42 88	$533 35
Charles G. Witbeck	Assistant engineer in charge	27	6 00 per day	162 00	9 70	171 70
C. C. Huestis	Assistant engineer	60	5 00 per day	300 00	23 66	323 66
Dorlon Clark	Leveler	27	4 50 per day	121 50	39	121 89
C. M. Pepson	Rodman	75	3 50 per day	262 50	22 28	284 78
F. J. Lempe	Rodman	57	3 50 per day	199 50	3 11	202 61
A. M. Evans	Rodman	27	3 50 per day	94 50	....	94 50
B. Toner	Chainman	60	2 50 per day	150 00	7 36	157 36
Wm. J. Gilmore	Chainman	71	2 50 per day	177 50	7 46	184 96
L. B. Jones	Chainman	60	2 50 per day	150 00	9 04	159 04
Charles Erlenwein	Chainman	52	2 50 per day	130 00	4 95	134 95
B. Frederick	Chainman	2	2 50 per day	5 00	3 36	8 36
H. J. Richardson	Chainman	18	2 50 per day	45 00	....	45 00
John Vischer	Chainman	30	2 50 per day	75 00	....	75 00
George McDonald	Chainman	27	2 50 per day	67 50	50	68 00
C. A. Cockcroft	Chainman	27	4 50 per day	121 50	39	121 89
Jay Capron	Chainman	76	5 00 per day	380 00	5 00	385 00
						$3,072 05

Incidental expenses.

Livery	$57 50	
Fuel and light	3 00	
Postage and telegraph	8 08	
Office rent	31 50	
Miscellaneous	68 87	
		168 95
		$3,241 00

EXTRAORDINARY REPAIRS — CHAMPLAIN CANAL.

Chapter 572, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Albert J. Himes	Resident engineer	....	....	$27 15	....	$27 15
John R. Kaley	Assistant engineer in charge	17	$2,000 00 per year	102 00	$5 90	107 90
F. A. Bagg	Rodman	27	6 00 per day	94 50	17 95	112 45
A. M. Evans	Rodman	5	3 50 per day	17 50	....	17 50
C. M. Pepson	Rodman	3	3 50 per day	10 50	6 50	17 00
George McDonald	Chainman	53	3 50 per day	132 50	2 00	134 50
Ralph Russell	Chainman	5	2 50 per day	12 50	8 00	20 50
Arthur O'Brien	Chainman	5	2 50 per day	12 50	12 00	24 50
C. F. Stowell	Draughtsman	....	....	50 00	....	50 00
						$511 50

Incidental expenses.

Office rent	$19 50	
Livery	52 00	
Postage and telegraph	1 25	
Stationery	23 60	
Miscellaneous	11 60	
		107 95
		$619 45

EXTRAORDINARY REPAIRS — ERIE CANAL, LENGTHENING LOCK NO. 20.

Chapter 572, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Albert J. Himes	Resident engineer	......	$2,000 00 per year	$27 15	$9 08	$36 23
T. C. Leutze	Assistant engineer in charge	6	6 00 per day	36 00	9 74	45 74
Charles G. Witbeck	Assistant engineer in charge	23	6 00 per day	138 00	1 78	139 78
Dorlon Clark	Leveler	10	4 50 per day	45 00	....	45 00
C. M. Pepson	Rodman	2	3 50 per day	7 00	3 78	10 78
A. M. Evans	Rodman	5	3 50 per day	17 50	....	17 50
Wm. J. Gilmore	Chainman	3	2 50 per day	7 50	6 86	14 36
H. J. Richardson	Chainman	4	2 50 per day	10 00	7 54	17 54
L. B Jones	Chainman	3	2 50 per day	7 50	6 36	13 86
Charles Erlenwein	Chainman	2	2 50 per day	5 00	3 81	8 81
C. A. Cockcroft	Chainman	3	4 50 per day	13 50	12 61	26 11
						$375 71
Incidental expenses.						
Labor					$2 00	
Livery					48 00	
Stationery					23 30	
Miscellaneous					8 90	
						82 20
						$457 91

EXTRAORDINARY REPAIRS — REPAIRING GLENS FALLS FEEDER.

Chapter 278, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
C. C. Huestis	Assistant engineer	6	$5 00 per day	$30 00	$16 72	$46 72
F. J. Lempe	Rodman	6	3 50 per day	21 00	16 72	37 72
B. Toner	Chainman	6	2 50 per day	15 00	16 72	31 72
L. B. Jones	Chainman	6	2 50 per day	15 00	16 72	31 72
						$147 88
	Incidental expenses.					
Postage and telegraph					45	
Miscellaneous					$4 05	
						4 50
						$152 38

EXTRAORDINARY REPAIRS — REPAIRING ROCKY RIFT FEEDER.

Chapter 655, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
T. C. Leutze	Assistant engineer in charge	6	$6 00 per day	$36 00	$5 21	$41 21
A. M. Evans	Rodman	1	3 50 per day	3 50	3 96	7 46
H. J. Richardson	Chainman	1	2 50 per day	2 50	3 96	6 46
Wm. J. Gilmore	Chainman	1	2 50 per day	2 50	3 96	6 46
						$61 59

EXTRAORDINARY REPAIRS — REPAIRING MOLE AT HOUGHTALING ISLAND.

Chapter 358, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Albert J. Himes	Resident engineer	....	$2,000 00 per year	$18 87	$7 96	$26 83
H. J. Richardson	Chainman	3	2 50 per day	7 50	2 76	10 26
						$67 09
Incidental expenses.						
Postage and telegraph					96	
Miscellaneous					$1 05	
						2 01
						$69 10

EXTRAORDINARY REPAIRS — NORTH STREET BRIDGE AT MECHANICVILLE.

Chapter 594, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
T. C. Lentze	Assistant engineer in charge	3	$6 00 per day	$18 00	$1 80	$19 80
Arthur O'Brien	Chainman	1	2 50 per day	2 50	....	2 50
						$22 30

Extraordinary Repairs — Lift-Bridge at Canajoharie, N. Y.

Chapter 592, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
C. C. Huestis	Assistant engineer	3	$5 00 per day	$15 00	$6 70	$21 70
F. J. Lempe	Rodman	3	3 50 per day	10 50	6 20	16 70
B. Toner	Chainman	3	2 50 per day	7 50	6 70	14 20
L. B. Jones	Chainman	3	2 50 per day	7 50	6 20	13 70
						$66 30

Incidental expenses.

Miscellaneous	75
	$67 05

Extraordinary Repairs — Shinnecock and Peconic Canal.

Chapter 358, *Laws of* 1894, *Chapter* 768, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Albert J. Himes	Resident engineer	....	$2,000 00 per year	$21 72	$15 99	$37 71
T. C. Leutze	Assistant engineer in charge	9	6 00 per day	54 00	23 61	77 61
C. A. Cockcroft	Chainman	68	4 50 per day	306 00	67 72	373 72
Wm. J. Gilmore	Chainman	8	2 50 per day	20 00	28 66	48 66
H. J. Richardson	Chainman	8	2 50 per day	20 00	28 66	48 66
L. B. Jones	Chainman	66	2 50 per day	165 00	42 89	207 89
						$794 25

Incidental expenses.

Office rent	$20 00	
Postage and telegraph	4 05	
Miscellaneous	43 50	
		67 55
		$861 80

SPECIAL SURVEYS — STATE BOARD OF CLAIMS.

Chapter 726, *Laws of* 1893, *and Chapter* 358, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
T. C. Leutze	Assistant engineer in charge	133	$6 00 per day	$798 00	$493 01	$1,291 01
Dorlon Clark	Leveler	43	4 50 per day	193 50	74 16	267 66
A. M. Evans	Rodman	4	3 50 per day	14 00	3 11	17 11
John H. Jones	Rodman	39	3 50 per day	136 50	68 87	205 37
James Ryan, Jr.	Rodman	26	3 50 per day	91 00	17 84	108 84
C. M. Pepson	Rodman	25	3 50 per day	87 50	19 18	106 68
B. Frederick	Chainman	47	2 50 per day	117 50	76 15	193 65
George R. Mann	Chainman	38	2 50 per day	95 00	73 42	168 42
R. A. Barrett	Chainman	51	2 50 per day	127 50	78 93	206 43
H. J. Richardson	Chainman	63	2 50 per day	157 50	125 29	282 79
Charles Erlenwein	Chainman	3	2 50 per day	7 50	8 58	16 08
Wm. J. Gilmore	Chainman	63	2 50 per day	157 50	108 69	266 19
Ralph Russell	Chainman	65	2 50 per day	162 50	165 69	328 19
Frank Lutz	Chainman	23	2 50 per day	57 50	47 46	104 96
Arthur O'Brien	Chainman	22	2 50 per day	55 00	27 70	82 70
Arthur O'Brien	Chainman	26	3 50 per day	9. 00	42 69	133 69
						$3,779 77
Incidental expenses.						
Labor					$16 00	
Postage and telegraph					16 02	
Livery					237 50	
Miscellaneous					63 30	
						372 82
						$4,152 59

Special Surveys — Examinations and Maps.

Chapter 726, *Laws of* 1893, *and Chapter* 358, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George W. Rafter	Engineer in charge	84	$10 00 per day	$840 00	$70 46	$910 46
C. H. Flanagan	Leveler	105	4 50 per day	472 50	759 55	1,232 05
Wallace Greenalch	Leveler	31	4 50 per day	139 50	....	139 50
Edward Styring	Leveler	11	4 50 per day	49 50	6 18	55 68
John H. Jones	Rodman	11	3 50 per day	38 50	....	38 50
John H. Higgins	Chainman	105	2 50 per day	262 50	2 05	264 55
Mortimer S. Smith	Chainman	4	3 50 per day	14 00	33 48	47 48
Guy H. Miller	Chainman	23	2 50 per day	57 50	26 21	83 71
Chauncey Hurlbut	Chainman	47	2 50 per day	117 50	7 80	125 30
John Hackett	Chainman	21	2 50 per day	52 50	14 67	67 17
						$2,964 35
Incidental expenses.						
Labor					$32 00	
Miscellaneous					53 25	
						85 25
						$3,049 60

SPECIAL SURVEYS — SURVEY GENESEE STORAGE.

Chapter 726, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George W. Rafter	Engineer in charge	29	$10 00 per day	$290 00	$169 55	$459 55
Wallace Greenalch	Leveler	10	4 50 per day	45 00	8 65	53 65
Wallace Greenalch	Rodman	16	3 50 per day	56 00	....	56 00
M. F. Wemple	Chainman	26	2 50 per day	65 00	9 64	74 64
M. S. Sweet	Chainman	26	2 50 per day	65 00	26 00	91 00
						$734 84
Incidental expenses.						
Livery					$22 15	
Miscellaneous					469 49	
						491 64
						$1,226 48

The foregoing tables are summarized as follows :

ORDINARY REPAIRS.		
Erie canal, chapter 89, Laws 1893	$9,395 29	
Champlain canal, chapter 89, Laws 1893	3,719 86	
		$13,115 15
EXTRAORDINARY REPAIRS.		
Repairing Cohoes dam, chapter 643, Laws 1893, chapter 463, Laws 1894	$4,069 72	
Constructing stone dam at Little Falls, chapter 480, Laws 1892, chapter 119, Laws 1893	11 97	
Improving Champlain canal, chapter 119, Laws 1893	3,511 50	
Lengthening berme, lock No. 19, Erie canal, chapter 119, Laws 1893	4,008 14	
Repairing Schoharie creek and upper and lower Mohawk aqueducts, chapter 5, Laws 1893	414 66	
Constructing of bridge at Ann street, Little Falls, chapter 197, Laws 1893	184 39	
Construction of bridge at Bridge street, Amsterdam, chapter 561, Laws 1893	315 61	
Approaches to Van Derwerken farm bridge at Waterford, chapter 294, Laws 1893	286 00	
Construction of bridge No. 15 (Fitzgerald bridge), Champlain canal, chapter 569, Laws 1893	330 33	
Dredging Albany basin, chapter 567, Laws 1893	846 98	
Improving Saranac river, chapter 141, Laws 1893	141 48	
Abating nuisance, Chemung canal and feeder, chapter 726, Laws 1893	54 15	
Shinnecock and Peconic canal, chapter 726, Laws 1893	264 19	
Strengthening and protecting berme bank near Schenectady, chapter 24, Laws 1894	3,241 00	
Improving Champlain canal, chapter 572, Laws 1894	6.9 45	
Lengthening berme, lock No. 20, Erie canal, chapter 572, Laws 1894	437 91	
Repairing Glens Falls feeder, chapter 278, Laws 1894	153 38	
Repairing Rocky Rift feeder, chapter 594, Laws 1894	61 59	
Repairing mole at Houghtaling island, chapter 358, Laws 1894	69 10	
Abutments and approaches to an iron bridge at Mechanicville, chapter 594, Laws 1894	28 30	
Lift-bridge at Canajoharie, chapter 592, Laws 1894	67 05	
Shinnecock and Peconic canal, chapters 358 and 768, Laws 1894	861 80	
		19,968 64
SPECIAL SURVEYS.		
Making surveys and maps for use of the State Board of Claims, chapter 726, Laws 1893, chapter 358, Laws 1894	$4,158 59	
Making surveys and maps required by State Engineer and Surveyor, chapter 726, Laws 1893, chapter 358, Laws 1894	3,049 60	
Making surveys, Genesee storage	1,286 48	
		8,498 67
Total		$41,530 46

TABLE OF CONTRACTS PENDING ON THE EASTERN DIVISION SEPTEMBER 30, 1894.

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Appropriation.	LEGISLATIVE ACT. Chapter.	LEGISLATIVE ACT. Year.	Engineer's preliminary estimate.	Engineer's estimate at contract price.	Payments to date.
ERIE CANAL.								
John Twomey	July 24, 1894	For lengthening at the foot berme, lock No. 20	$40,000 00	572	1594	$35,005 35	$34,294 65	$5,406 00
Troy Public Works Co.	Aug. 25, 1894	For improvement and repairs to Rocky Rift feeder	8,000 00	655	1894	7,094 75	....	....
Wm. B. Wemple Sons	July 24, 1894	Machinery for drawing boats into lock No. 20	....	572	1894	1,200 00	1,200 00	....
CHAMPLAIN CANAL.								
Flood & Sherrill	July 23, 1894	Vertical wall at Glens Falls feeder	15,000 00	278	1894	12,977 08	9,124 86	....
SHINNECOCK AND PECONIC CANAL.								
P. J. Brummelkamp	July 23, 1894	Piling and protecting the banks of the Shinnecock and Peconic canal	15,000 00	763	1894	12,865 80	12,547 80	4,368 00
P. J. Brummelkamp	July 24, 1894	Restoring and protecting approaches to swing-bridge over S. and P. canal	3,500 00	358	1894	2,808 90	2,798 70	357 00
HUDSON RIVER.								
Wm. D. Fuller	July 23, 1894	Mole on Houghtaling island in Hudson river	1,200 00	358	1894	691 00	935 00	....

Table of Contracts on Eastern Division Completed During the Year Ending September 30, 1894.

ERIE CANAL

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Legislative Act. Chapter.	Legislative Act. Year.	Appropriation.	Engineer's estimate at contract price.	Final estimate.	Remarks.
Hilt & Johnson	June 23, 1893	Substructure of lift-bridge over Erie canal at Water street, Albany	394	1893	$12,000 00	$2,551 75	$2,980 94	Includes substructure and superstructure.
Hilt & Johnson	June 22, 1893	Superstructure of lift-bridge over Erie canal at Water street, Albany				3,261 49	3,800 59	
Rapp & Co.	July 28, 1892	Stone dam across the Mohawk river at Little Falls	480 119	1892 1893	19,000 00	9,954 00	12,964 94	
Hilton Bridge Con. Co.	Nov. 23, 1893	Foot-bridge over Erie canal at Fifteenth street, West Troy	137	1893	1,200 00	1,712 75	1,175 00	
Buffalo Bridge & Iron Co.	June 8, 1893	For 35 bents for upper and lower Mohawk aqueducts	5	1893	75,000 00	....	9,611 58	
Wm. B. Wemple Sons	July 15, 1893	Machinery for drawing boats into lock No. 19, Erie canal	119	1893	38,000 00	1,200 00	1,200 00	
John J. Hallock	July 3, 1893	Lengthening at the foot berme, lock No. 19, Erie canal				29,459 80	28,718 03	
Kellogg Iron Works	Jan. 23, 1894	Constructing bridge at Bridge street, Amsterdam	561	1893	4,500 00	2,363 70	3,247 31	
Kellogg Iron Works	Jan. 17, 1894	Constructing bridge at Ann street, Little Falls	197	1893	3,500 00	2,706 30	2,894 64	
Troy Public Works Co.	March 8, 1894	Constructing 4,150 feet of vertical wall on berme bank at Schenectady	24	1894	35,000 00	33,668 00	31,359 98	
Cunningham & Monty	Aug. 4, 1893	Repairing dam across the Mohawk river at Cohoes	643 462	1893 1894	110,000 00	87,289 00	104,814 86	

CHAMPLAIN CANAL.

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Legislative Act. Chapter.	Legislative Act. Year.	Appropriation.	Engineer's estimate at contract price.	Final estimate.	Remarks.
Troy Public Works Co.	Sept. 25, 1893	Construction of approaches to Vanderwerken farm bridge at Waterford	394	1893	3,500 00	2,748 00	2,964 14	
Cunningham & Monty	Nov. 9, 1893	Construction of bridge No. 15 (Fitzgerald bridge), with approaches and abutments	569	1893	4,000 00	2,753 25	2,806 21	
Troy Public Works Co.	Sept. 25, 1893	Improving 6,500 feet of Champlain canal from Wilbur's basin waste-weir southerly	119	1893	50,000 00	35,444 25	47,785 94	

TABLE OF CONTRACTS ON EASTERN DIVISION COMPLETED, ETC. — (*Concluded*).

SHINNECOCK AND PECONIC CANAL.

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Legislative Act. — Chapter	Legislative Act. — Year.	Appropriation.	Engineer's estimate at contract price.	Final estimate.	Remarks.
P. J. Brummelkamp......	July 7, 1893	For restoring and protecting the approaches to swing-bridge on the Shinnecock and Peconic canal.	726	1893	$10,000 00	$10,869 16	$14,135 34	
ALBANY BASIN.								
P. W. Myers..............	Aug. 18, 1893	Improving the Albany basin by dredging	567	1893	20,000 00	11,900 00	14,940 93	

APPENDIX C.

REPORT

OF THE

DIVISION ENGINEER

OF THE

MIDDLE DIVISION

FOR THE

YEAR ENDING SEPTEMBER 30, 1894.

APPENDIX C.

DIVISION ENGINEER'S OFFICE,
SYRACUSE, *October* 1, 1894.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor:*

SIR.— I have the honor herewith to submit my annual report for the middle division of the New York State canals, for the fiscal year, ending September 30, 1894.

ENGINEER DEPARTMENT.

This department was under the charge of Russell R. Stuart, as division engineer, until January 22 last, and David E. Whitford, as resident engineer, until February 28. Since those dates it has been under the charge of the undersigned as division engineer and George A. Morris as resident engineer.

Table No. 1, hereto annexed, shows the names of the engineers duly appointed by the State Engineer and Surveyor, time employed, rate of compensation, and amount paid during the year, with the amount of other miscellaneous expenditures, for ordinary and extraordinary repairs.

Table No. 2 exhibits contracts in force at the close of the fiscal year, together with engineer's estimate of cost of each piece of work and the amount paid thereon.

Table No. 3 exhibits contracts completed and settled during the fiscal year, with engineer's estimate and the total cost of each piece of work as returned in final account.

Table No. 4 exhibits water record of Cayuga and Cross lakes and Seneca river, taken tri-annually since 1884, in pursuance of concurrent resolutions of the Senate and Assembly, passed in 1884.

The work of this department on account of ordinary repairs, other than preparing maps, plans and specifications for new work

authorized by the Legislature, is and must continue to be very diversified in its character, furnishing plans of every description to the Superintendent of Public Works and section superintendents, establishing bench-marks for controlling height of water in the canal, advising as to weak and dangerous places and structures, and how best to repair or protect them, and at all times to respond to the call of the officers in charge of the ordinary repairs of the canal in every possible way.

The percentage of the cost of engineering to the actual cost of work done under the several contracts appears high. Yet, when it is understood that the work is distributed over almost every central county of the State wherever the Legislature may authorize improvements, it must be seen that much help and large expense for travel and maintenance must be the result. The force employed has been kept at a minimum to do the work required of this department.

EXTENT OF THE MIDDLE DIVISION.

	Miles.	Total.
This division comprises that portion of the Erie canal lying between the east lines of Oneida county and the south line of Wayne county..	97.02	
Also the following unabandoned lateral canals:		
Oswego canal, from Syracuse to Oswego......	37.78	
North and south side-cuts and slips at Salina..	2.02	
Slips at Liverpool, Oswego canal............	0.25	
Baldwinsville side-cut	0.59	
Cayuga and Seneca canal, Montezuma to Cayuga and Seneca lakes	22.99	
Black River canal, Rome to Lyons Falls.......	35.52	
Old Oneida Lake canal, Higginsville to first lock	1.05	
Chenango canal, from Erie canal to Fayette street	0.05	
Chemung canal, lake level...................	2.53	
		199.80

RIVER IMPROVEMENTS.

	Miles.	Total.
Black river, Lyons Falls to Carthage	42.50	
Onondaga outlet, Onondaga lake to Seneca river	0.75	
Oneida river, Three River Point to Brewerton and Oneida lake	20.00	
Seneca river towing-path, Mud lock to Baldwinsville	5.83	
Seneca river, Baldwinsville to Jack's Reefs (not used)	11.75	
Ithaca inlet, Cayuga lake to Ithaca	2.05	
Seneca lake outlet, from Cayuga and Seneca canal to Seneca lake	0.17	
		83.05

NAVIGABLE FEEDERS.

Limestone creek feeder, Erie canal to Fayetteville	0.83	
Butternut creek feeder, Erie canal to feeder dam above Dunlap's mills	1.67	
Camillus feeder, Erie canal to Camillus	1.04	
Delta feeder, foot of lock No. 9, Black River canal, to Delta	1.40	
Black river feeder, Booneville to head of pond at Forestport	11.29	
		16.23
Total		299.08

ARTIFICIAL FEEDERS — NOT NAVIGABLE.

	Miles.
Chenango canal, summit level	5.31
Leland pond feeder	0.31
Madison brook feeder	2.99
West branch feeder	5.83
Bradley's brook feeder	0.67
Hatch's lake feeder	0.23
Kingsley brook feeder	1.87

	Miles.
Oriskany creek feeder	0.53
Mohawk feeder to Rome	0.03
Oneida creek feeder	2.91
Cowasselon creek feeder	0.40
Chittenango creek feeder	0.28
Cazenovia lake outlet (improved)	0.51
Tioughnioga river feeder	1.00
De Ruyter reservoir outlet	0.12
Orville feeder (unnavigable portion)	0.55
Camillus feeder (unnavigable portion)	0.65
Carpenter brook feeder	0.18
Skaneateles creek feeder	0.09
Putnam brook feeder	0.20
Centerport feeder	0.18
Owasco creek feeder (including 859 feet of iron pipe)	2.10
Lansing Kill feeder	1.80
Sugar river feeder	0.14
New outlet of third Bisby lake	0.06
New outlet of Canachagala lake	0.16
Total	29.10

SOURCES OF WATER SUPPLY.

The canals upon this division are supplied with water from the following named sources:

Erie Canal — Frankfort and Rome Levels.

(Three and three hundred and fifty-six thousandths miles of Frankfort level on middle division. The Rome level, lock No. 46 to lock No. 47 — 55.957 miles.)

	Cubic feet per minute.
Leland's pond, Madison brook reservoir, Eaton brook reservoir, Bradley brook reservoir, Hatch's lake, Kingsley brook reservoir and Oriskany creek, feed through the Chenango canal, Oriskany creek and Oriskany creek feeder into the Rome level, six miles west of lock No. 46	6,000

	Cubic feet per minute.
Mohawk river, Black river, Forestport pond, Forestport reservoir, White lake reservoir, Chub lake, Sand lake, first, second and third Bisby lakes, Woodhull reservoir, Twin lakes, South branch reservoir, North branch reservoir, Canachagala lake, feed through the Rome feeder and Black River canal into the Rome level at Rome 14 miles west of lock No. 46	13,000
Oneida creek enters canal through feeder, 30 miles west of lock No. 46	1,000
Cowasselon creek enters canal through feeder 31 1-2 miles west of lock No. 46	200
Cazenovia lake reservoir (for 100 days), Erieville reservoir (for 100 days) and Chittenango creek enter canal through Chittenango creek feeder, 41 1-2 miles west of lock No. 46	5,641
De Ruyter reservoir (for 100 days) enters canal through Limestone creek (Fayetteville) feeder, 50 miles west of lock No. 46	3,891
Limestone creek (natural flow) enters canal through Limestone creek (Fayetteville) feeder, 50 miles west of lock No. 46	500
Jamesville reservoir (for 60 days) enters canal through Orville feeder, 52 miles west of lock No. 46	2,000
Butternut creek (natural flow) enters canal through Orville feeder, 52 miles west of lock No. 46	500
Total	32,732

Short level, from lock No. 47 to No. 48 = .188 of a mile; fed from Rome level.

Mile level, from lock No. 48 to 49 = .714 of a mile; fed from Rome level through short level.

Syracuse level, from lock No. 49 to 50 = 5.014 miles; fed from Rome and Jordan levels.

Jordan level, from lock No. 50 to 51 = 14.903 miles.

	Cubic feet per minute.
Otisco lake reservoir feeds through Camillus feeder into the canal four miles west of lock No. 50	5,146
Nine-mile creek (natural flow), fed through Camillus feeder into canal, four miles west of lock No. 50......	800
Carpenter brook enters canal through feeder, 10 miles west of lock No. 50................................	200
Skaneateles lake reservoir feeds into canal at Jordan, 13 miles west of lock No. 50....................	8,766
Total	14,912

Port Byron level, from lock No. 51 to 52 - 7.793 miles; from Jordan level, through lock No. 51.

Putnam brook feeder, at Weedsport..................	200
Owasco lake reservoir, through feeder at Port Byron....	4,033
Total	4,233

Montezuma level; from lock No. 52 to Wayne county = 9.098 miles; from Port Byron level through lock No. 52 and from Lake Erie............................	4,000

Oswego Canal.

Erie canal, at Syracuse	10,000
Seneca river	54,000
Oneida river	20,000
Total	84,000

Cayuga and Seneca Canal.

Seneca lake	18,000
Erie canal, at Montezuma............................	4,000
Total	22,000

SUMMARY OF WATER SUPPLY MEASURED.

Erie Canal.

	Cubic feet per minute. Amounts.	Totals.
Frankfort and Rome levels	32,732	
Jordan level	14,912	
Port Byron level	4,233	
		51,877

Oswego Canal.

From Seneca river	54,000	
From Oneida river	20,000	
		74,000

Cayuga and Seneca Canal.

From Seneca lake	18,000	
		18,000
Total		143,877

BLACK RIVER CANAL AND RIVER IMPROVEMENT.

CANALS.	Elevation in feet above tide-water.	Surface area in acres.	Average area in acres.	Average depth in feet.	Capacity in cubic feet.
White Lake reservoir (not used)	....	....	296	5	64,468,800
Chub Lake reservoir (approximate)	1,599	....	200	4	34,848,000
Sand Lake reservoir	....	....	306	15	199,940,400
Woodhull reservoir (two years in filling)	1,854	1,236	1,118	18	876,601,440
First, Second and Third Bisby lakes (approximate)	....	....	....	3½	40,000,000
Canachagala lake (approximate)	....	....	320	4	55,756,800
North Lake reservoir (can fill twice yearly)	1,891	423	277	28	337,851,360
South Lake reservoir	2,019	518	372	26	421,312,320
Twin Lake reservoir (approximate)	....	....	175	8	60,984,000
Forestport pond	....	....	....	....	....
Mohawk river, through Delta feeder	....	....	....	....	....
Pond above Lyon's Fall dam	....	....	....	....	....

River Improvements.

Forge pond	....	....	....	....	....
First lake of the Fulton chain	1,691	....	....	....	....
Second lake of the Fulton chain	1,691	....	....	....	....
Third lake of the Fulton chain	1,691	....	....	....	....
Fourth lake of the Fulton chain	1,691	....	....	....	....
Fifth lake of the Fulton chain	1,691	9	....	....	....
Sixth lake of the Fulton chain	1,772	109	....	....	....
Seventh lake of the Fulton chain	1,772	867	....	......	....
Eighth lake of the Fulton chain	1,776	309	....	....	....
Black river	....	....	....	....	....
Moose river	....	....	....	....	....
Beaver River reservoir	....	....	....	....	....

Navigation.

The only interruption to navigation during the year was occasioned by a small break in the towing-path at the aqueduct, north of Fulton, on the Oswego canal, July 12, which was repaired by the section superintendent under advice and directions of this department. Navigation was suspended six days. The number of boats delayed was very limited.

On May 2, the breast wall to Fort Bull wast-weir, west of Rome, was carried out, but no interruption to navigation was occasioned. The breast wall was relaid by the superintendent on plan recommended by this department.

The water supply has been abundant the entire year for all purposes of navigation. The following exhibits the condition of the water in all reservoirs south of the Erie canal. The figures denote the amount drawn from high-water mark on October 1, 1894:

Reservoir.	Feet.	Inches.
Skaneateles lake	1	....
Otisco lake	4	5
Jamesville	8	11
Cazenovia lake	1	....
Erieville	7	8
De Ruyter	7	1
Eaton brook	38	3
Madison brook	18	....
Kingsley brook	10	....
Hatch's lake	6	6
Leland pond	10	....

The east end of the long level between Syracuse and Utica is most likely to suffer from lack of water in dry seasons, as its principal supply enters the Erie canal, at Rome, from the reservoirs in the Adirondack forests. All the water from the entire system of reservoirs that flow south must pass through the Forestport feeder, thence into the Black River canal at Booneville, which is the summit level, about 750 feet above the Erie canal at Rome.

This feeder is 11.29 miles in length and of same sectional area as the Black River canal, and is continually used for navigation. In order to preserve all the water accumulated in the reservoirs tributary to this feeder, for the use of the Erie canal, this feeder must be greatly improved by bottoming out its entire length, and at many of the curves widened to increase the flow.

As this feeder is now, all efforts to increase the storage capacity of reservoirs is of no practical advantage, as the feeder will not conduct the amount of water now in store, and certainly not sufficient to keep the east end of the long level of the Erie canal to its full height in a very dry season. I most respectfully urge a liberal appropriation for this work, as I deem it of vital importance that all available water may be conducted to the Erie canal at such time as it may be needed.

I have not made an actual estimate based upon cross-sections of the work; but, from personal examination, over the whole line, I think it safe to say that an appropriation of $25,000 would be required to do the work in a proper manner.

FORESTPORT RESERVOIR.

The work of constructing a reservoir above Forestport pond on Black river was commenced in 1884, and has been prosecuted as the necessary appropriations have been made until its completion during the present year. While the cost of this reservoir has been very large for the amount of water it will store, it will be very useful in supplying the canals when in immediate need; the large lakes in the North Woods, used as reservoirs, are so far from the canal, that several days are required before the canal can feel the effect from feeding therefrom. With a supply at Forestport immediate relief can be furnished.

A map and plan of Foresport reservoir is hereto appended.

The Erie canal is deprived of a very large amount of water by the abandonment of the Bisby lakes in pursuance of section 3, chapter 274, Laws of 1889. These lakes should be restored to the canal system, as the most available supply in case of need, beyond the present storage capacity. With the Bisbys restored and a

new channel cut, extending from the Bisbys to Woodhull, as has been recommended in former reports, a very large amount of water would be made available for the Erie canal; this improvement should be made.

Extraordinary repairs done by contract under the supervision of the engineer department during the fiscal year:

ERIE CANAL.

CONSTRUCTION OF WROUGHT-IRON BRIDGE AT MADISON STREET, ROME.

Chapter 601, *Laws of* 1892.

The work was let on August 3, 1892, to W. H. Shepard & Sons; completed.

Payments prior to October 1, 1893	$2,975 00
Payments since October 1, 1893	880 02
Amount of final	$3,855 02

CONSTRUCTING SUBSTRUCTURE FOR LIFT-BRIDGE AT MULBERRY STREET, SYRACUSE.

Chapter 610, *Laws of* 1892.

The work was let to Brumelkamp & Lane, April 14, 1893; completed.

Payments prior to October 1, 1893	$1,411 00
Payments since October 1, 1893	877 07
Amount of final	$2,288 07

CONSTRUCTING SUPERSTRUCTURE FOR LIFT-BRIDGE AT MULBERRY STREET, SYRACUSE.

Chapter 610, *Laws of* 1892.

The work was let to W. H. Shepard & Sons Bridge Co., April 20, 1893; completed.

Payments prior to October 1, 1893	$4,250 00
Payments since October 1, 1893	5,196 72
Final account	$9,446 72

CONSTRUCTING TWO LIFT-BRIDGES AND ONE FIXED BRIDGE OVER THE ERIE CANAL AT UTICA.

Chapter 560, *Laws of* 1893.

This work was let to Hilton Bridge Construction Co., November 15, 1893.

The plan adopted for the two lift-bridges was entirely new and ingenious, but was found impracticable in its operation and defective in many of its details.

New plans have been prepared for the lifting apparatus, which, it is hoped, will overcome the objections in the original plan. The necessary changes will involve a large additional expense and make further appropriation necessary.

There have been estimates on this work and payments made to contractors to September 30, 1894, $36,610.

RAISING APPROACHES TO SENECA STREET BRIDGE AT WEEDSPORT

Chapter 161, *Laws of* 1893.

This work was let to W. H. Eldridge, August 18, 1893; completed.

Final account, paid since October 1, 1893, $776.40.

CONSTRUCTING BRIDGE OVER OLD ABANDONED ERIE CANAL AT JAMES STREET, ROME.

Chapter 562, *Laws of* 1893.

This work was let to W. J. Cramond, September 25, 1893; completed.

Final account, $1,941.81.

CONSTRUCTING BRICK SEWER AT CANASTOTA.

Chapter 328, *Laws of* 1893.

This work was let to Arthur D. Osborne, November 9, 1893; completed.

Final account, $6,332.81.

CONSTRUCTING SUBSTRUCTURE TO HOIST-BRIDGE AT CLINTON STREET, SYRACUSE.

Chapter 57, *Laws of* 1893.

The work was let to Pidgeon & Co., January 20, 1894; completed.

Final account, $5,406.26.

CONSTRUCTING SUPERSTRUCTURE FOR HOIST-BRIDGE AT CLINTON STREET, SYRACUSE.

Chapter 57, *Laws of* 1893.

This work was let February 23, 1894, to The Wrought-Iron Bridge Co., of Canton, Ohio; completed.

This bridge is constructed upon a plan entirely different from any heretofore erected, and works to the entire satisfaction of the city and State authorities. It is proposed to erect this style of bridge at Geddes street, under act chapter 385, Laws of *1894*.

Final account, $7,971.60.

CONSTRUCTING SPILLWAY AT EATON BROOK RESERVOIR.

Chapter 471, *Laws of* 1892.

This work was let June 24, 1893, to Hughes Brothers; completed.

Payments prior to October 1, 1893................	$5,049 00
Payments since October 1, 1893..................	6,978 71
Final account	$12,027 71

BLACK RIVER CANAL.

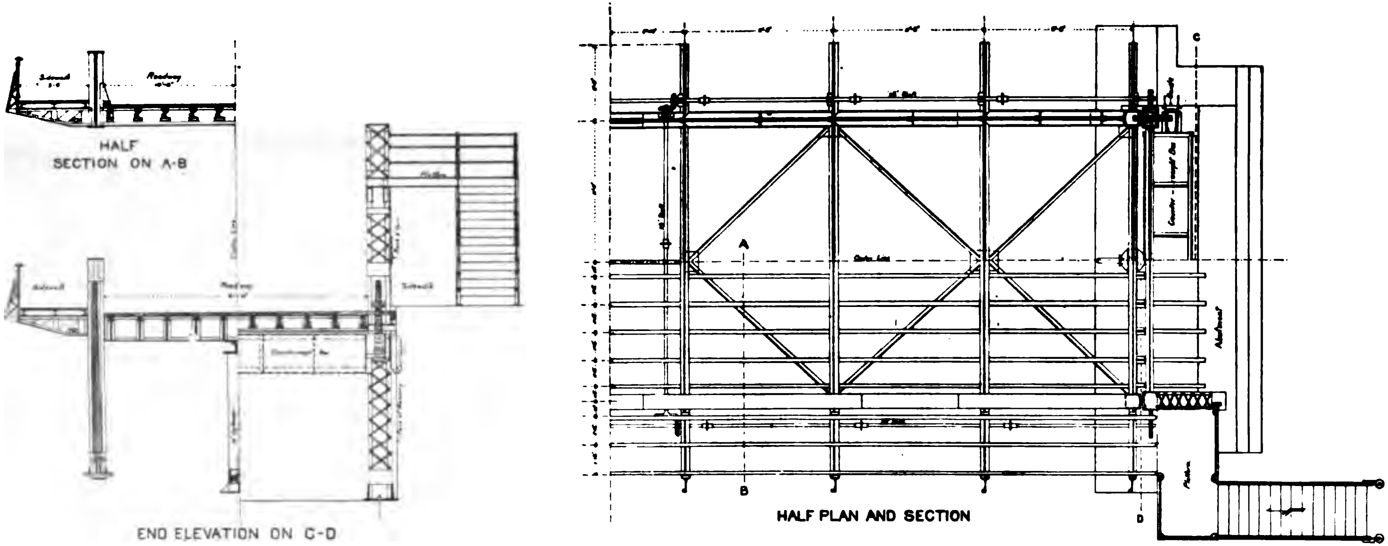
REBUILDING LOCK NO. 76.

Chapter 119, *Laws of* 1893.

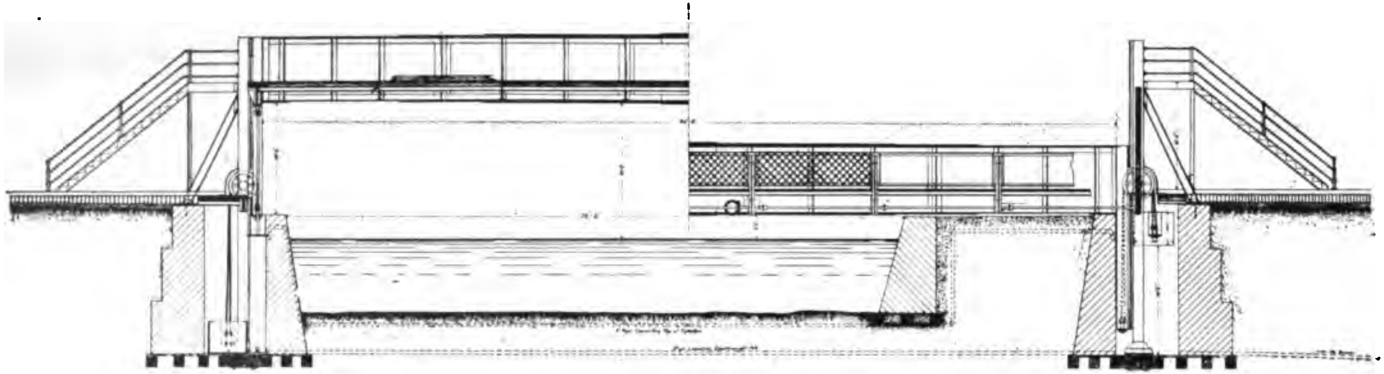
This work was let to J. J. Hallock, April 4, 1893, and finished last fiscal year.

Payments prior to October 1, 1893..............	$10,795 00
Payments since October 1, 1893..................	1,911 69
Final account	$12,706 69

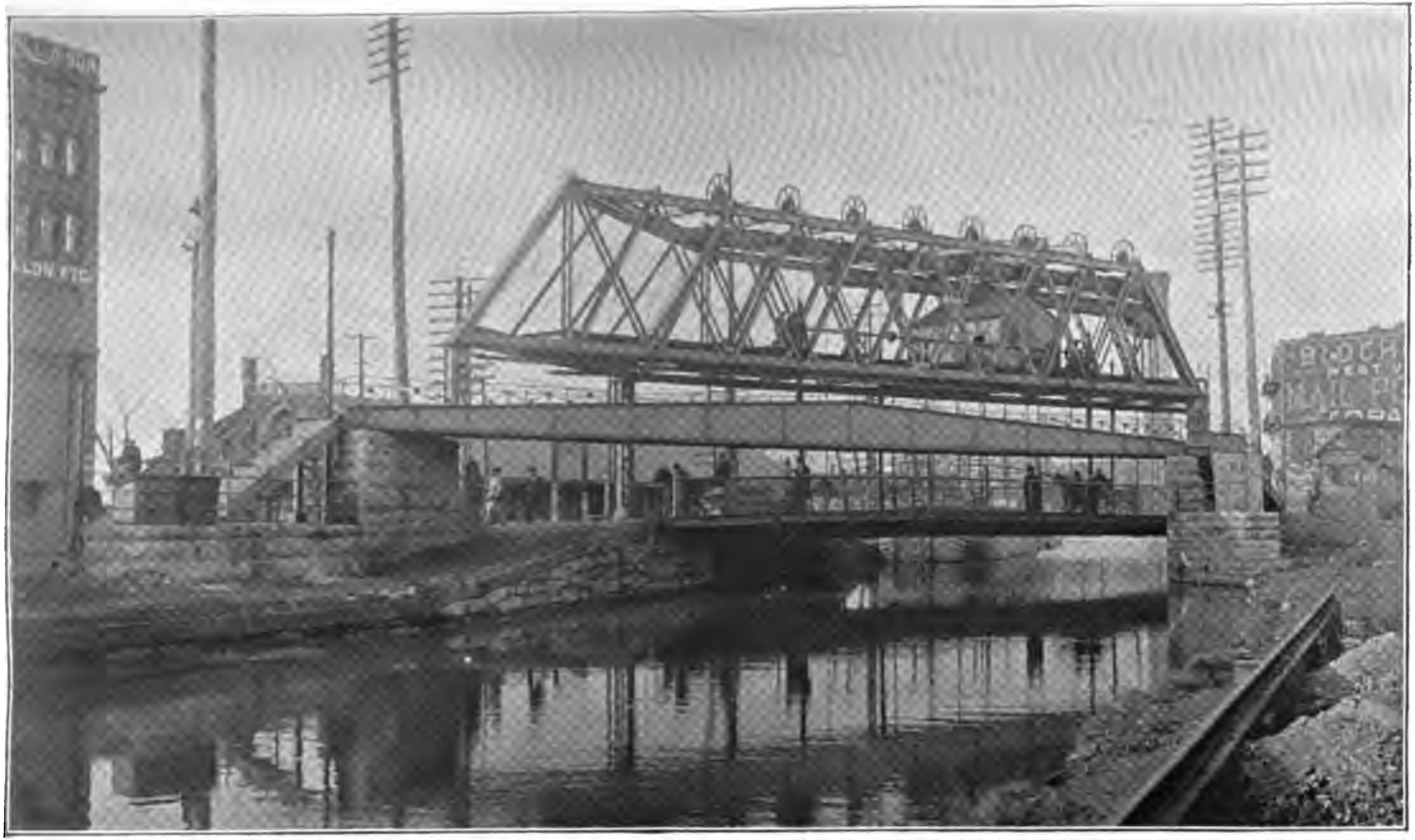
CLINTON STREET LIFT BRIDGE OVER THE ERIE CANAL AT SYRACUSE, N. Y.



CLINTON STREET BRIDGE
OVER ERIE CANAL
SYRACUSE, N. Y.



CLINTON STREET BRIDGE,
OVER ERIE CANAL
SYRACUSE, N. Y.



NORTH SALINA STREET LIFT BRIDGE OVER THE OSWEGO CANAL AT SYRACUSE, N. Y.

NORTH SALINA STREET LIFT BRIDGE OVER THE OSWEGO CANAL AT SYRACUSE, N. Y.

RAISING DAM ON THE BEAVER RIVER AT STILLWATER.

Chapter 469, *Laws of* 1892.

This work was let to F. Louis Faas & Co., September 6, 1892; completed.

Payments prior to October 1, 1893	$8,755 00
Payments since October 1, 1893	2,969 17
Final account	$11,724 17

COMPLETION OF THE RESERVOIR DAM ABOVE FORESTPORT POND.

Chapter 494, *Laws of* 1892.

The work was let to Beckwith & Quackenbush, July 26, 1892; completed.

Payments prior to October 1, 1893	$13,209 00
Payments since October 1, 1893	14,743 31
Final account	$27,952 31

CLEARING FLOW GROUND IN RESERVOIR ABOVE FORESTPORT POND.

Chapter 342, *Laws of* 1891.

The work was let to Beckwith & Quackenbush, July 20, 1892. Payments have been made on account of this contract prior to October 1, 1893, $8,483, since which time there has been nothing done. The work included in this contract was abandoned and the contractor filed claim against the State with Board of Claims, rather than have the final account made up, according to the terms of the contract, by the engineer department.

CONSTRUCTING A SLUICE IN SPILLWAY AT FOOT OF NORTH BRANCH RESERVOIR.

Chapter 726, *Laws of* 1893.

This work was let to A. C. Hall, September 11, 1894. The contractor is now at work, and the structure will be completed before January 1.

There have been no payments made on this contract.

By the construction of this work all timber that will float will be cut from a belt of several miles in width around North lake, as this structure will enable the lumbermen to float the logs from the lake into Black river. The question of the propriety of stripping these forests of their spruce and hemlock may not be within the line of my duty except so far as it ultimately affects the water supply for the canals.

The reservoirs in the Adirondack forests are an absolute necessity for maintaining full depth of water in the Erie canal, and any depletion of the forests will eventually be seen in a reduced supply in the reservoirs. It is not uncommon that North lake be filled twice, and even three times during a single year, which can not be said of any other of the large storage lakes. A certainty of a supply in North lake makes it invaluable to the canal system.

In order to run 15,000,000 feet of logs through this chute, as is expected will be done next spring, at least 10 feet of water will be drawn from the whole surface of the lake. Whether the lake will again fill before the opening of navigation in the spring is a question that can not be determined in advance.

I respectfully submit that the interest of the State is paramount to that of any individual or club, and that no structures should be built whereby the supply of water would be first at the disposal of private parties, leaving the canals to be maintained from the residue.

For a better understanding, I submit a small drawing of the structure now building.

REBUILDING LOCK No. 18, A. VAN WAGNER & CO., CONTRACTORS; REBUILDING LOCK No. 28, MULCAHY & CO., CONTRACTORS; REBUILDING LOCK No. 37, MULCAHY & CO., CONTRACTORS.

Chapter 572, *Laws of* 1894.

This work was let July 23, 1894. The locks will be of cut stone laid in hydraulic cement. The dressing of the face-stone is well under way, and at the close of navigation the work preparatory to rebuilding will be prosecuted vigorously, so as to insure completion by the time of opening the canal next spring.

BALDWINSVILLE CANAL.

STONE DAM ACROSS THE SENECA RIVER AT BALDWINSVILLE.

Chapter 113, *Laws of* 1893, *and chapter* 130, *Laws of* 1894.

This work was let to Messrs. Hughes Bros. & Bangs, August 14, 1893, and has been prosecuted diligently since. During the extreme cold weather last winter work was suspended. On the breaking up of the ice in the spring and the usual high water in the river, a breach occurred in the old wooden dam, which has added very materially to the cost of coffer-dams, and has delayed the work; however, it is expected that the entire work will be completed before the season closes.

Payments prior to October 1, 1893	$1,530 00
Payments since October 1, 1893	21,165 00
Total payments	$22,695 00

MISCELLANEOUS.

CONSTRUCTING HIGHWAY AT HEAD OF OWAGENA LAKE.

Chapter 658, *Laws of* 1893.

This work was let to Edward S. Candee, August 14, 1893; completed.

The highway at and across the head of Owagena (Cazenovia) lake is built upon a bottomless swamp; every precaution to prevent settling was taken, but from continual settling the quantity of embankment required to raise the roadway to the height proposed was so much increased that the appropriation was exhausted before the work could be completed.

Amount payment prior to October 1, 1893	$1,887 00
Amount payment since October 1, 1893	3,103 39
Final account	$4,990 39

COMPLETING REPAIRS TO HIGHWAY AT HEAD OF OWAGENA LAKE.

Chapter 335, *Laws of* 1894.

The work was let to Edward S. Candee, July 21, 1894, and has been completed. Should no further settling occur, the highway will for all time be sufficiently above high water in the lake to make its use entirely safe.

Total cost of work, $4,391.50.

IMPROVEMENT OF CHANNEL OF BUTTERNUT CREEK.

Chapter 119, *Laws of* 1893.

The work was let to John E. Pidgeon, November 9, 1893.

This is an independent channel for Butternut creek below the Erie canal, cutting off bends in old channel which are claimed to obstruct the flow of water when a large amount is discharged from the canal aqueduct into the creek, thus overflowing surrounding farm lands.

The new channel passes under the New York, Ontario and Western railroad, the West Shore railroad and the New York Central and Hudson River railroad at different points.

The New York Central and Hudson River Railroad Company objected to the proposed work, and secured an injunction against the contractor and State officers from opening either end of the new channel into the old creek, or of excavating under their tracks, at which point is a bridge of sufficient span to pass the creek. The work has progressed and the channel excavated nearly to the points named in the injunction. The work was stopped by the Superintendent of Public Works, as the appropriation is nearly exhausted, and final settlement with the contractor ordered. Without the removal of the injunction and the completion of the work, public health will be in danger, from a pond of several acres of impounded water. While the propriety of the State assuming to do this work in the first instance is very doubtful, there can be no question of its obligation in some way to abate a nuisance that is sure to result unless the channel is opened at each end and under the three railroad bridges.

The final account of work so far done amounts to $6,798.35.

HIGHWAY BRIDGE OVER BUTTERNUT CREEK.

Chapter 470, *Laws of* 1894.

This work was let to Edward S. Candee, July 21, 1894, to construct abutments under the present iron road-bridge over the new channel for Butternut creek, and is fully completed.

Final account, $869.42.

COMPLETION OF PIER AND BREAKWATER AT THE FOOT OF CANANDAIGUA LAKE.

Chapter 172, *Laws of* 1894.

This work was let to James Robinson, July 21, 1894, and is completed, at a total cost, as per final account, of $1,794.11.

CLEANING AND REPAIRING STATE DITCH AT LIVERPOOL.

Chapter 119, *Laws of* 1893.

This work was let to Edward S. Candee, July 21, 1894, and is completed.

Final account, $3,347.14.

REMOVING OBSTRUCTIONS IN CAYUGA LAKE.

Chapter 279, *Laws of* 1894.

This work was let to John J. Hallock, August 23, 1894, and the contractor has commenced work; no payments made as yet.

PROTECTION OF THE BERME BANK OF THE CAYUGA AND SENECA CANAL AT THE FOOT OF SENECA LAKE.

Chapter 424, *Laws of* 1894.

This work was let to Brayer & Albaugh, October 5, 1894; no work done.

REMOVING BARS AND DREDGING THE CHANNEL OF CAYUGA INLET.

Chapter 234, *Laws of* 1892, *chapter* 656, *Laws of* 1894.

This work was let to Hingston & Wood, August 23, 1894; in progress.

REPAIRS TO MADISON BROOK FEEDER, LEBANON FEEDER AND THE SUMMIT LEVEL OF THE ABANDONED CHENANGO CANAL.

Chapter 570, *Laws of* 1894.

This work was let to Edward S. Candee, September 27, 1894; in progress.

WORK AUTHORIZED, NOT UNDER CONTRACT.

Chapter 423, Laws of 1894, provides for constructing vertical wall in cement on berme side of the Erie canal in the city of Utica, from Gibert to Turner streets, and provides an appropriation therefor, $10,000.

Plans, estimates and specifications have been prepared for the portion of this wall of most importance, and of sufficient extent to exhaust the appropriation.

Chapter 572, Laws of 1894, provides for improving the Cayuga and Seneca canal, by rebuilding all or a portion of the wall between the level next below lock No. 3, and excavating and concreting, if necessary, the bottom of the canal on said level, and appropriates therefor, $15,000.

Plans, estimates and specifications have been prepared for this work.

Chapter 359, Laws of 1894, provides for the construction of a drain in Foster street, in the village of Whitesboro, and appropriates therefor, $1,500.

Plans, estimates and specifications have been prepared for this work.

Chapter 93, Laws of 1893, provides for re-erecting an old iron bridge (taken down to be replaced by a hoist-bridge), at Sycamore street, Liverpool, and appropriates therefor, $1,500.

Plans, estimates and specifications for the removal of the Geddes Street bridge, in Syracuse, and re-erecting the superstructure at Sycamore street, Liverpool, have been made.

Chapter 385, Laws of 1894, provides for the construction of a hoist-bridge at Geddes street, Syracuse, and appropriates $7,500 toward the cost thereof. The city of Syracuse has appropriated a like sum toward the final cost. Plans for this work are being prepared for a bridge similar to the one lately erected at Clinton street, Syracuse.

Chapter 119, Laws of 1893, appropriates $10,000 for improvement of Oswego canal; and chapter 572, Laws of 1894, appropriates a further sum of $30,000 to the same object. This sum of $40,000 will be expended to restore aprons to dams on the Oswego river. A full description of the necessity of this work appears in another part of this report.

Chapter 358, Laws of 1894, provides for cleaning and repairing State ditch, between Seneca Falls and Waterloo, and appropriates therefor, $3,000. Also for cleaning out Stae ditch at Port Byron, $700.

This work will be taken up at once and the necessary plans, estimates and specifications made.

IMPORTANT REPAIRS NEEDED.

First. While the prism of the Erie canal in the center may safely be said to be down to, or below bottom, caused by the action of propeller wheels to steamboats and tugs, throwing the debris to either side, yet the channel in many places is too narrow to permit the free passage of two loaded boats abreast. There has been much done toward cleaning out the prism with dredges; still the yearly accumulation is more than the amount removed.

I respectfully suggest that provision be made for restoring the prism to its original capacity of 52 1-2 feet wide at bottom and seven feet in depth.

The Oswego canal is in even worse condition than the Erie. On account of fewer boats, and practically no propeller tugs navigating the canal the prism is gradually filling, so that it is necessary to raise the water surface. This process endangers the banks, reduces the space between surface of water, and the bridges below the legal height (12 feet) endangering boats and bridges, and necessitates placing flush-boards upon all the dams, involving questions of damage to lands inundated. If this canal is long to be maintained at seven feet in depth, it will be necessary to expend a large sum of money in cleaning out the prism.

At least three steam dredges should be constantly employed on the middle division. The Cayuga and Seneca canal is in much the same condition as the Oswego canal.

The Black River canal is of small sectional area, and the work of cleaning the prism can be done in the spring before the opening of navigation.

STRUCTURES

Upon the Erie canal are mostly in fair condition. Masonry in locks, aqueducts, bridges and culverts need pointing, and in some cases relaid. The pits to most of the diving culverts should be cleaned out to prevent obstruction to the flow of water.

The composite culvert, east of Higginsville, was cleaned out and repaired before the opening of navigation this year, but it is too small to carry off the water from the large water-shed that must pass under the canal at that point. To add to the difficulty a long waste-weir is located near this culvert and the overflow must pass under the canal through the culvert referred to. The result is the overflow of considerable land until the water is raised to the height in the canal, when it flows over the waste-weir breast into the canal. Claims are constantly being filed with the board of claims for damages caused by the overflows.

I recommend that the waste-weir referred to be taken out and rebuilt across the old Oneida Lake canal near Higginsville. I also advise the removal of the old tumble-gate at the entrance of the abandoned, enlarged Oneida Lake canal, at Durhamville, and the towing-path built of earth in its place.

The head of lock No. 47 should be taken up and rebuilt. Before the opening of navigation, last spring, extensive repairs were made to the foundation of this lock, which had become undermined, preventing working the locks singly; the filling of one lock resulted in filling the one at its side. The repairs of last spring were so thoroughly done that no trouble has been experienced so far this season. I think the importance of permanent repairs to this lock fully justifies the expenditure necessary to put its failure beyond question.

The wood trunks to aqueducts, and wood superstructures to bridges require constant watchfulness and repairs.

I suggest that steel should be used in place of wood in replacing trunks to aqueducts. The floor to the trunk of several

aqueducts upon this division is six inches above canal bottom. If iron or steel beams are substituted for timber in bottom of the trunks, a full depth of seven feet of water could be secured. The cost of steel would be somewhat greater than of wood, but its renewal every 10 years would not be required.

Bridges should be built of iron on all important streets and roads. Many iron bridges in cities are being substituted with hoist or swing-bridges. In all of these cases, the superstructure taken down should be re-erected where most needed, rather than storing at State shop, and ultimately being lost.

The superstructure taken down from Clinton street, in Syracuse, should be re-erected at Memphis, in place of a wooden structure that is unsafe.

There are several Whipple-iron bridges now at State shop, which could, to good advantage, be set up on important streets and highways at a very moderate expense; very much less than the continual repairs of old wooden structures.

The swing-bridge over the Erie canal at Salina street, in the city of Syracuse, is entirely inadequate to do the work required of it.

The structure has a single roadway and two narrow sidewalks, on the principal street in the city, and carrying a double-track electric railroad; was, when built, barely sufficient for the traffic at that time, but the large increase of population and the heavy electric cars constantly crossing has, and is, largely overtaxing the bridge, to the great inconvenience of the people.

I recommend the construction of a hoist-bridge similar to the one at Clinton street, with two roadways and sidewalks.

The feeder at Port Byron should be an open channel, doing away with the present pipe arrangement. This has been recommended in several former reports, and its necessity grows more urgent every year. There is much more water in the Owasco creek than can be passed through the present pipe (which is nearly rusted out), which could be made available on the Port Byron level if a larger conduit were provided; an open feeder is practicable and every way desirable.

The feeder at foot of Cazenovia (Owagena) lake has become so filled with silt that the lake can be drawn down only 17

inches, whereas it is intended to be drawn four feet, if necessary, to supply the long level. This is one of the most important reservoirs, and, owing to its proximity to the canal, can be used as a feeder, when water is low, on very short notice.

Crane Brook aqueduct needs extensive repairs to the west abutment. Breaks have occurred at that point several times and the repairs have been made during season of navigation in a temporary manner. There has been no trouble at that point this season, but the importance of the structure and its precarious condition would seem to justify thorough repairs this winter.

The berme abutment to east bridge at Jordan must be rebuilt. It has been with the utmost care retained during the present season and can not be kept up another year.

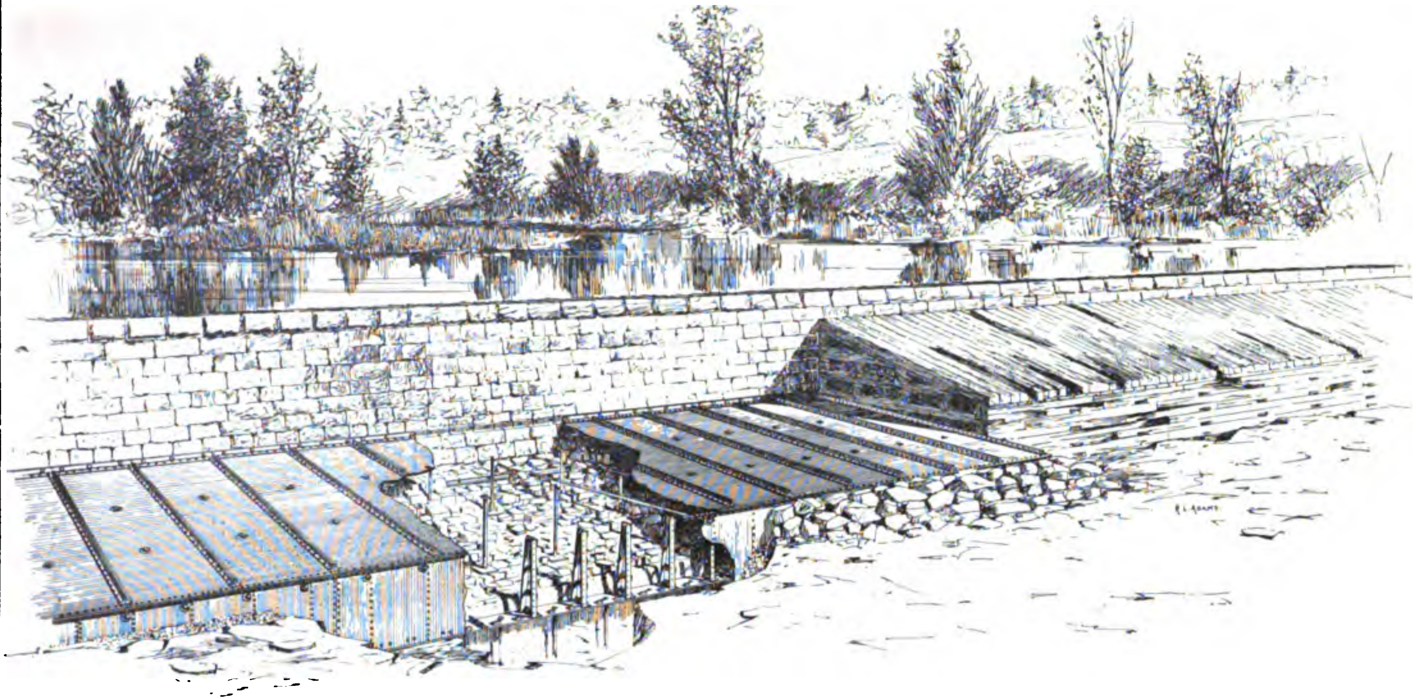
The tunnel under the Erie canal at Syracuse for the New York Central and Hudson River railroad I deem a menace to the city. It is leaking water from the canal continually, and should it become beyond control, the whole long level, over 50 miles, might be emptied upon the city. The railroad company should be required at once to build a proper structure.

The artificial feeders should all be cleaned to their original capacity. While this work will not involve a very great outlay of money, its necessity is absolute. From long neglect of the reservoirs and feeders, the canals have suffered for water; which can easily be corrected at moderate cost. I submit that the work above outlined should be done before the opening of navigation next spring.

OSWEGO CANAL.

The most important structures upon this canal are the locks and dams across the Oswego river. These structures are all of stone and in good repair, except that the apron at Oswego dam has been entirely carried away, as has also a portion of the apron at Braddocks, or Battle Island dam.

The old aprons were of wood, and the bed rock is of such a character that it is impossible to secure the timber to the rock. Failure at any one of the dams on the Oswego river would completely close navigation on that canal. Feeling the importance



PROPOSED STEEL APRON FOR BRADDOCKS OR BATTLE ISLAND DAM ACROSS THE OSWEGO RIVER.

of these dams, which can not be long maintained without aprons, plans for cut-stone aprons have been prepared to replace those carried away, which plans have been approved by the State Engineer and Surveyor, and adopted by the Canal Board, and proposals are advertised for by the Superintendent of Public Works under chapter 119, Laws of 1893, and chapter 572, Laws of 1894. The other structures upon this canal require constant attention and repair as necessity appear.

BLACK RIVER CANAL.

The most important structures upon this canal are the locks. There are 70 locks between the Erie canal at Rome and the summit at Booneville. Of these five have been rebuilt within a few years. From Booneville to Lyons Falls there are 37 locks; of these one has been rebuilt.

The stone of which the locks from the summit to Rome were originally built is of so poor quality that it is very difficult to keep the locks in working order, and if this canal is to be maintained, not less than five locks should be rebuilt every year until all the old locks are taken up.

Locks 18, 28 and 37 are now under contract to be rebuilt of gray limestone during the coming winter.

In selecting locks to be rebuilt it is very difficult to determine those requiring first attention, where all are so bad. The side walls are often bulged toward the chamber, so as to necessitate dressing off on one or both sides several inches, in order to give width of chamber sufficient to pass boats. After this is done a few times the face-stone are all cut away and gates are so out of plumb, that nothing short of rebuilding will answer.

From the summit north to Lyons Falls the stone is much better and the locks will answer for some years, unless the foundations fail.

CAYUGA AND SENECA CANAL.

This canal, extending from Montezuma to Cayuga and Geneva, will require, in order to maintain seven feet depth of water, a

large amount of work in bottoming out of the prism and raising banks, which for a long distance between Montezuma and Cayuga are barely above the surface of the water.

The work to be done the coming winter on the short level at Seneca Falls will prevent a large loss of water and add to the safety of navigation.

The protection of the berme bank at Geneva under chapter 424, Laws of 1894, for which an appropriation of $15,000 is made, will be extended as far as the appropriation will allow, about 3,500 feet. This improvement is a desirable one, and if continued along the whole lake front, a further appropriation of $30,000 will be necessary.

Mr. George A. Morris, resident engineer, has, at my request, examined most of the reservoirs upon this division, with a view of noting their condition and repairs needed. His conclusions I embody in this report.

WOODHULL.

Spillway is in a very bad condition. It was built of timber and riprap slope. The timber work is rotted away, and should be rebuilt of stone, if possible.

The gatetender's house is uninhabitable and should be rebuilt.

SAND LAKE.

Wickets leak and need attention. There should be a new gate-house built of stone or iron to secure it against the attack of lumbermen, who, without authority, assume the right to draw water whenever they desire to drive logs from the lake.

CANACHAGALA.

The dam is in bad condition and needs rebuilding, with stone, if possible.

NORTH LAKE.

The wooden discharge culvert consists of five spaces, each three by five feet, extending entirely through the embankment about 25 feet below the surface of the lake when full. The tim-

ber in this structure is too badly decayed to be trusted longer. I recommend that three or four cast-iron pipes, 30 inches in diameter, be substituted for the wood trunks. Plans and estimate for this work will be submitted to you at an early day.

TWIN LAKES.

Dam needs repairing. This, like most of the structures in the North Woods, was built of wood, which quickly decays. To rebuild of stone would add largely to the cost, but would be much more durable.

BEAVER RIVER.

Middle gate can not be operated. Race needs cleaning out and rack built to prevent logs and debris from floating to the gates.

There are three sink-holes on the inside of the dam, through which water flows when the reservoir is full. The cribs on either side of gates should be refilled with proper material. This reservoir is not used for supplying the Erie canal with water, but flows north into the Black river. The management of this reservoir and one at Fulton Chain is vested in commissioners, under act chapter 168, Laws of 1894.

FULTON CHAIN.

Repairs have been made this season.

ERIEVILLE.

The riprap wall on inside slope of dam needs rebuilding for about 80 feet. Gatehouse should be repainted.

Bridge over feeder on the main roads should be rebuilt. Riprap of embankment at south end of the reservoir has been washed away and the highway is being encroached upon.

LELAND POND.

Rubbish should be removed from the gates and rack provided to prevent flood wood flowing into and stopping flow of water.

Masonry of waste-weir should be rebuilt.

MADISON BROOK.

In good condition, except some repairs are needed to highway and bridge at the upper end of the reservoir.

EATON BROOK.

This is a very important reservoir, but in the condition it is now, very much of its value to the Erie canal is lost. One of four valves can not be opened and the other three can not be closed. The result is a continuous flow of three pipes the year around, while there is water in the reservoir. I recommend that the valves be replaced with new ones and pipes extended through the culvert, so as to be accessible at all times.

BRADLEY BROOK.

Gates can not be operated. New guard-rail is needed.

KINGSLEY BROOK.

One valve should be replaced with new one, whenever it becomes desirable to repair the feeder to conduct the water to the Erie canal. This is a large reservoir and can be made to flow to the Erie canal, but the feeder would require very extensive repairs in cleaning out, repairing breaks and structures. Until it is needed it may not be desirable to repair it, other than the several bridges over the feeder, etc. The water now flows south, and is not used for canal purposes.

LEBANON BROOK.

Gates not capable of operation. A new set should be provided.

The reservoirs are the source of supply of water for the Erie canal from Port Byron to Albany, as no water from Lake Erie can be carried east of lock No. 52, at Port Byron, and if the reservoirs are not properly maintained, navigation of the canals

will suffer. The State has sufficient storage capacity to supply the Erie and Black River canals at all times, if they are kept in repair.

It seems that the reservoirs have been sadly neglected, for the same condition is met in all cases. The cry for more water could be effectually stopped by putting the reservoirs and feeders, now connected with the canal system, in good condition, and I earnestly recommend that provision be made for that purpose, rather than responding to the demand for more reservoirs.

The danger of storing large bodies of water over the heads of the people by imperfect structures has been practically demonstrated by the breaking away of North Lake reservoir some years ago. And the same result may be realized again if the structures are not put and kept in complete repair.

INSPECTORS.

The system of employment of inspectors by the Superintendent of Public Works, on each piece of work, creates a division of authority, without division of responsibility as to the character of work done. All contracts, for construction of new work, provides that the division or resident engineer have full supervision, and shall decide all questions that may arise, involving classification, kind and quality of material, and the manner of doing the work; and when completed they are required to swear that the work is fully completed according to the terms of the contract and specifications. During the past year very little trouble has been experienced with inspectors appointed by the Superintendent of Public Works, for the reason that their self-consciousness of unfitness for the position assigned them deterred them from assuming authority or responsibility that could not be held in check by the engineer department.

Inspectors should be selected by the State Engineer and be responsible to him, in order to be of any service on the work; they would then be selected with a view as to qualification for

the particular piece of work assigned them, and would receive instructions from the division and resident engineers as their authority, which they do not now accept in all cases.

Most of the inspectors heretofore appointed have no knowledge of the work they are expected to supervise, and the money paid for such service is of no benefit to the work, and in most cases results in taking from the appropriation funds that could and should be used in the work.

The division engineer, feeling his responsibility for the character of the work done upon his division, feels justified in recommending that no inspector be appointed, unless asked for by the State Engineer, and then only one that is thoroughly competent, by experience, to construct the work he is to supervise, with instructions to co-operate with the engineer in charge.

TELEPHONE LINE.

In order to relieve the management of the several reservoirs in the North Woods from the necessity of sending special courier from Booneville, with orders to draw or cease drawing water, at an expense of at least $1,000 yearly, I recommend the construction of a telephone line from Forestport to North lake and Woodhull, about 20 miles. The line could be constructed very cheaply, and its operation would cost comparatively little.

With a telephone line, as proposed, daily orders could be given to the reservoir tenders as to the need of water for the canals, thereby saving a large proportion of the water. As now conducted, water runs to waste very many days every year, that should and could be saved. It is safe to say that the amount of water wasted that might be saved will equal the amount stored in North lake, that cost over $100,000, by the construction of a telephone line, at a cost of perhaps $1,500.

In conclusion, I beg leave to say that it has been my purpose in preparing this report to touch only upon the most important work, as it appears to me, without regard to its effect upon

outside interests or previous management, believing that the canals should be put and kept in the most perfect condition practicable, in order to meet the growing competition for cheaper transportation, thereby fully serving the purpose of their construction and maintenance by the people of this State.

All of which is respectfully submitted.

W. H. H. GERE,
Division Engineer.

TABLE No. 1.

Statement showing the names, rank and compensation of engineers employed on the Middle Division of the New York State Canals, together with incidental expenses for the fiscal year ending September 30, 1894.

ORDINARY REPAIRS — ERIE CANAL.

Chapter 89, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. R. Stuart	Division engineer	....	$2,400 00 per year	$249 41	$71 84	$321 25
W. H. H. Gere	Division engineer	....	2,400 00 per year	537 65	15 00	552 65
D. E. Whitford	Resident engineer	....	2,000 00 per year	325 46	45 90	371 36
George A. Morris	Resident engineer	....	2,000 00 per year	317 80	62 07	379 87
A. C. Driscoll	Assistant engineer in charge	25	6 00 per day	156 00	35 68	191 68
Edwin Styring	Leveler	12	4 50 per day	54 00	26 92	80 92
Paul L. Schultze	Leveler	76	4 50 per day	342 00	22 15	364 15
Theo. A. Hendrickson	Leveler	149	4 50 per day	670 50	60 00	730 50
W. Greenalch	Leveler	5	4 50 per day	22 50	19 46	41 96
M. J. Ross	Rodman	7	3 50 per day	24 50	13 82	38 32
Henry Blum	Chainman	129	4 00 per day	516 00	33 54	549 54
B. F. Bauder	Chainman	3	2 50 per day	7 50	....	... .
B. F. Bauder	Chainman	131	4 00 per day	524 00	....	531 50
Thos. J. Welch	Chainman	4	2 50 per day	10 00	4 18	14 18
Edward J. Berry	Chainman	105	2 50 per day	262 50	49 39	311 89
John C. Gallavin	Chainman	75	2 50 per day	187 50	....	187 50
Fred J. Wagner	Chainman	120	2 50 per day	300 00	27 41	327 41
Wm P. Dowd	Chainman	30	2 50 per day	75 00	....	75 00
Saml. L. Knox	Chainman	35	2 50 per day	87 50	....	87 50
S. L. Way	Chainman	32	2 50 per day	80 00	19 56	99 56
Chas. W. Field	Chainman	33	2 50 per day	240 00	14 82	254 82
Wm. Rowlands	Chainman	68	2 50 per day	170 00	17 36	187 36
John Schimmel	Chainman	26	2 50 per day	65 00	....	65 00
John J. Schmid	Chainman	41	2 50 per day	102 50	4 14	106 64
						$5,870 56

Incidental expenses.

Office rent	$17 00	
Stationery	300 08	

Fuel and light	88 73	
Postage and telegraph	150 87	
Miscellaneous	1,491 82	
Livery	12 00	
		1,660 45
		$7,931 01

ORDINARY REPAIRS — OSWEGO CANAL.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. R. Stuart	Division engineer	....	$2,400 00 per year	$135 15	$23 20	$158 35
W. H. H. Gere	Division engineer	....	2,400 00 per year	39 44	1 90	41 34
D. E. Whitford	Resident engineer	....	2,000 00 per year	80 96	55	81 51
George A. Morris	Resident engineer	....	2,000 00 per year	32 88	6 06	38 94
A. C. Driscoll	Assistant engineer in charge	1	6 00 per day	6 00	....	6 00
Theo. A. Hendrickson	Leveler	1	4 50 per day	4 50	3 58	8 08
Chas. W. Field	Chainman	1	2 50 per day	2 50	50	3 00
T. V. Owen	Chainman	1	2 50 per day	2 50	55	3 05
Edward J. Berry	Chainman	1	2 50 per day	2 50	55	3 05
Edwin Styring	Leveler	1	4 50 per day	4 50	....	4 50
J. C. Gallavin	Chainman	2	2 50 per day	5 00	....	5 00
						$352 82

Incidental expenses.

Miscellaneous	1 00
	$353 82

TABLE No. 1 — (*Continued*).

ORDINARY REPAIRS — BLACK RIVER CANAL.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. R. Stuart	Division engineer	....	$2,400 00 per year	$123 36	$21 22	$144 58
W. H. H. Gere	Division engineer	....	2,400 00 per year	110 56	29 77	140 33
D. E. Whitford	Resident engineer	....	2,000 00 per year	214 12	55 10	269 22
George A. Morris	Resident engineer	....	2,000 00 per year	82 18	78 66	160 84
A. C. Driscoll	Assistant engineer in charge	17	6 00 per day	102 00	11 10	113 10
Edwin Styring	Leveler	157	4 50 per day	828 00	29 75	857 75
M. J. Ross	Rodman	180	3 50 per day	630 00	29 85	659 85
T. V. Owens	Chainman	101	2 50 per day	252 50	5 10	257 60
S. Mott Stuart	Chainman	135	2 50 per day	337 50	7 50	345 00
Fred J. Wagner	Chainman	3	2 50 per day	7 50	5 82	13 32
						$2,961 59
Incidental expenses.						
Livery					$15 00	
Fuel and light					11 21	
Office rent					24 00	
Postage and telegraph					5 74	
Miscellaneous					3 50	
						59 45
						$3,021 04

TABLE No. 1 — (*Continued*).

ORDINARY REPAIRS — CAYUGA AND SENECA CANAL.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$19 78	....	$19 78

SUMMARY.

Erie canal	$7,931 01
Oswego canal	858 82
Black River canal	3,021 04
Cayuga and Seneca canal	19 78
Total ordinary repairs	$ 1,825 60

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — LIFT-BRIDGE AT MULBERRY STREET, SYRACUSE.

Chapter 610, *Laws of* 1892.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. R. Stuart	Division engineer	....	$2,400 00 per year	$6 57	....	$6 57
D. E. Whitford	Resident engineer	....	2,000 00 per year	27 40	....	27 40
A. C. Driscoll	Assistant engineer in charge	5	6 00 per day	30 00	....	30 00
E. J. Berry	Chainman	1	2 50 per day	2 50	....	2 50
Samuel L. Knox	Chainman	38	2 50 per day	95 00	....	95 00
						$161 47
Incidental expenses.						
Postage and telegraph						27
						$161 47

TABLE NO. 1 -- (*Continued*).

EXTRAORDINARY REPAIRS — IMPROVING CHANNEL OF BUTTERNUT CREEK.

Chapter 119, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. R. Stuart	Division engineer	....	$2,400 00 per year	$59 18	$30 50	$89 68
D. E. Whitford	Resident engineer	....	2,000 00 per year	5 48	....	5 48
George A. Morris	Resident engineer	....	2,000 00 per year	16 44	3 00	19 44
A. C. Driscoll	Assistant engineer in charge	14	6 00 per day	84 00	34 50	118 50
E. J. Berry	Chainman	33	2 50 per day	82 50	38 95	121 45
J. C. Gallavin	Chainman	7	2 50 per day	17 50	3 25	20 75
Fred. J. Wagner	Chainman	13	2 50 per day	32 50	12 10	44 60
Thos. J. Welch	Chainman	1	2 50 per day	2 50	1 00	3 50
S. Mott Stuart	Chainman	1	2 50 per day	2 50	1 00	3 50
Chas. W. Field	Chainman	3	2 50 per day	7 50	1 50	9 00
Wm. Rowlands	Chainman	5	2 50 per day	12 50	1 00	13 50
						$449 40
Incidental expenses.						
Livery					$21 00	
Postage and telegraph					34	
Miscellaneous					92	
						22 26
						$471 66

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — SEWER AT CANASTOTA, N. Y.

Chapter 328, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. R. Stuart	Division engineer	....	$2,400 00 per year	$13 15	$2 68	$15 83
W. H. H. Gere	Division engineer	....	2,400 00 per year	26 80	....	26 80
D. E. Whitford	Resident engineer	....	2,000 00 per year	5 48	1 34	6 82
George A. Morris	Resident engineer	....	2,000 00 per year	33 36	....	33 36
A. C. Driscoll	Assistant engineer in charge	15	6 00 per day	90 00	5 02	95 02
Theo. A. Hendrickson	Leveler	20	4 50 per day	90 00	8 50	98 50
Paul L. Schultze	Leveler	17	4 50 per day	76 50	10 04	86 54
Edwin Styring	Leveler	9	4 50 per day	40 50	....	40 50
Thos. J. Welch	Chainman	2	2 50 per day	5 00	3 68	8 68
E. J. Berry	Chainman	12	2 50 per day	30 00	9 20	39 20
John C. Gallavin	Chainman	3	2 50 per day	7 50	3 84	11 34
S. L. Way	Chainman	51	2 50 per day	127 50	7 44	134 94
C. W. Field	Chainman	20	2 50 per day	50 00	1 68	51 68
Fred. J. Wagner	Chainman	7	2 50 per day	17 50	....	17 50
Wm. Rowlands	Chainman	7	2 50 per day	17 50	....	17 50
						$688 71
Incidental expenses.						
Postage and telegraph					$0 80	
Miscellaneous					15 85	
						16 65
						$705 36

TABLE NO. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — BRIDGE AT SOUTH JAMES STREET, ROME, N. Y.

Chapter 562, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
D. E. Whitford	Resident engineer	....	$3,000 00 per year	$16 44	$2 06	$18 50
A. C. Driscoll	Assistant engineer in charge	3	6 00 per day	18 00	2 56	20 56
Theo. A. Hendrickson	Leveler	17	4 50 per day	76 50	34 10	110 60
Thos. J. Welch	Chainman	2	2 50 per day	5 00	5 12	10 12
E. J. Berry	Chairman	1	2 50 per day	2 50	2 56	5 06
John C. Gallavin	Chainman	5	2 50 per day	12 50	12 62	25 12
						$189 96
Incidental expenses.						
Postage and telegraph					$1 09	
Miscellaneous					8 95	
						10 04
						$200 00

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — RAISING DAM ON BEAVER RIVER AT STILLWATER.

Chapter 469, *Laws of* 1892.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. R. Stuart	Division engineer	....	$2,400 00 per year	$18 15	$34 80	$47 95
D. E. Whitford	Resident engineer	....	2,000 00 per year	38 36	33 32	71 68
F. A. Bagg	Rodman	81	3 50 per day	283 50	28 20	311 70
E. F. Heffron	Chainman	90	2 50 per day	225 00	27 14	252 14
						$688 47
Incidental expenses.						
Labor					$9 75	
Postage and telegraph					4 78	
Miscellaneous					2 00	
						16 53
						$700 00

EXTRAORDINARY REPAIRS — BRIDGE OVER TWITCHELL CREEK.

Chapter 224, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. R. Stuart	Division engineer	....	$2,400 00 per year	$18 15	$10 25	$28 40
D. E. Whitford	Resident engineer	....	2,000 00 per year	82 88	....	82 88
E. F. Heffron	Chainman	27	2 50 per day	67 50	6 97	74 47
						$180 75
Incidental expenses.						
Miscellaneous						25
						$181 00

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — LIFT-BRIDGE AT CLINTON STREET, SYRACUSE, N. Y.

Chapter 57, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$164 38	....	$164 38
D. E. Whitford	Resident engineer	....	2,000 00 per year	5 48	....	5 48
George A. Morris	Resident engineer	....	2,000 00 per year	115 07	$7 17	122 24
A. C. Driscoll	Assistant engineer in charge	44	6 00 per day	264 00	....	264 00
Edward J. Berry	Chainman	33	2 50 per day	82 50	20	82 70
Fred. J Wagner	Chainman	2	2 50 per day	5 00	....	5 00
Chas. W. Field	Chainman	15	2 50 per day	37 50	20	37 70
Wm. Rowlands	Chainman	24	2 50 per day	60 00	....	60 00
						$741 50
Incidental expenses.						
Postage and telegraph					$2 69	
Miscellaneous					451 65	
Stationery					4 16	
						458 50
						$1,200 00

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — REBUILDING LOCK No. 76, BLACK RIVER CANAL.

Chapter 119, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. B. Stuart	Division engineer	....	$2,400 00 per year	$13 15	$16 91	$30 06
D. E. Whitford	Resident engineer	....	2,000 00 per year	71 24	11 18	82 42
Edwin Styring	Leveler	32	4 50 per day	144 00	11 47	155 47
M. J. Rosa	Rodman	13	3 50 per day	45 50	2 24	47 74
						$315 69
Incidental expenses.						
Postage and telegraph						25
						$315 94

EXTRAORDINARY REPAIRS — COMPLETION OF HIGHWAY ACROSS HEAD OF OWAGENA LAKE.

Chapter 335, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$13 15	$3 30	$16 45
George A. Morris	Resident engineer	....	2,000 00 per year	38 36	20 30	58 66
A. C. Driscoll	Assistant engineer in charge	6	6 00 per day	36 00	30 84	66 84
Edwin Styring	Leveler	2	4 50 per dey	9 00	3 06	12 06
Ed. J. Berry	Chainman	5	2 50 per day	12 50	4 56	17 06
Ed. J. Berry	Chainman	15	3 50 per day	52 50	9 68	62 18
Wm. Rowlands	Chainman	4	2 50 per day	10 00	7 62	17 62
L. Kavanaugh	Chainman	2	2 50 per day	5 00	5 12	10 12
						$260 99
Incidental expenses.						
Postage and telegraph					$0 25	
Miscellaneous					4 50	
						4 75
						$265 74

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — CLEARING FLOWED GROUND AT STILLWATER.

Chapter 119, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
D. E. Whitford	Resident engineer	....	$2,000 00 per year	$21 92	$16 91	$38 83
F. A. Bagg	Rodman	27	3 50 per day	87 50	7 46	94 96
						$133 79
Incidental expenses.						
Postage and telegraph					$0 54	
Miscellaneous					50	
						1 04
						$134 83

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — RECONSTRUCTING HIGHWAY ACROSS HEAD OF OWAGENA LAKE.

Chapter 658, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. R. Stuart	Division engineer	....	$2,400 00 per year	$19 73	$16 18	$35 91
A. C. Driscoll	Assistant engineer in charge	3	6 00 per day	18 00	7 68	25 68
Theo. A. Hendrickson	Leveler	1	4 50 per day	4 50	....	4 50
Edward J. Berry	Chainman	24	2 50 per day	60 00	30 86	90 86
John C. Gallavin	Chainman	3	2 50 per day	7 50	....	7 50
						$164 45
Incidental expenses.						
Livery					$8 50	
Postage and telegraph					25	
						8 75
						$173 20

TABLE No. 1 -- (*Continued*).

EXTRAORDINARY REPAIRS — STONE DAM AT BALDWINSVILLE.

Chapter 113, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. R. Stuart	Division engineer	....	$2,400 00 per year	$85 49	$18 20	$103 69
W. H. H. Gere	Division engineer	....	2,400 00 per year	177 55	3 75	181 30
D. E. Whitford	Resident engineer	....	2,000 00 per year	54 80	5 35	60 15
George A. Morris	Resident engineer	....	2,000 00 per year	93 15	13 60	106 75
A. C. Driscoll	Assistant engineer in charge	66	6 00 per day	396 00	43 60	439 60
Edwin Styring	Leveler	1	4 50 per day	4 50	50	5 00
C. M. Pepson	Rodman	50	3 50 per day	175 00	....	175 00
Thomas J. Welch	Chainman	95	2 50 per day	237 50	44 00	281 50
Edward J. Berry	Chainman	5	2 50 per day	12 50	7 00	19 50
John C. Gallavin	Chainman	11	2 50 per day	27 50	9 50	37 00
August Niebehr	Chainman	28	2 50 per day	70 00	....	70 00
Wm Rowlands	Chainman	2	2 50 per day	5 00	1 50	6 50
Fred. J. Wagner	Chainman	53	2 50 per day	132 50	10 74	143 24
J. J. Schmid	Chainman	1	2 50 per day	2 50	1 00	3 50
L. Kavanagh	Chainman	1	2 50 per day	2 50	1 00	3 50
						$1,636 23
Incidental expenses.						
Office rent					$38 84	
Postage and telegraph					3 75	
Miscellaneous					35 87	
						80 96
						$1,709 19

TABLE NO. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — LIFT AND FIXED BRIDGES AT GENESEE STREET, UTICA, N. Y.

Chapter 560, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. R. Stuart	Division engineer	....	$2,400 00 per year	$46 04	$23 79	$69 83
W. H. H. Gere	Division engineer	....	2,400 00 per year	78 90	7 72	86 62
D. E. Whitford	Resident engineer	....	2,000 00 per year	43 84	17 98	61 82
George A. Morris	Resident engineer	....	2,000 00 per year	32 88	9 08	41 96
A. C. Driscoll	Assistant engineer in charge	21	6 00 per day	126 00	33 02	159 02
Theodore A. Hendrickson	Leveler	1	4 50 per day	4 50	3 16	7 66
Paul L. Schultze	Leveler	154	4 50 per day	693 00	62 88	755 88
C. M. Pepson	Rodman	28	3 50 per day	98 00	....	98 00
Thos. F. Goggins	Chainman	38	3 50 per day	133 00	....	133 00
Ed. J. Berry	Chainman	5	2 50 per day	12 50	15 79	28 29
E. F. Heffron	Chainman	63	2 50 per day	157 50	4 24	161 74
Thos. J Welch	Chainman	2	2 50 per day	5 00	6 32	11 32
C. W. Field	Chainman	6	2 50 per day	15 00	10 64	25 64
Fred. J. Wagner	Chainman	57	2 50 per day	142 50	6 55	149 05
J. J. Schmid	Chainman	103	2 50 per day	257 50	....	257 50
Wm. J. Gilmore	Chainman	24	2 50 per day	60 00	....	60 00
B. Toner	Chainman	24	2 50 per day	60 00	....	60 00
John Schimmel	Chainman	37	2 50 per day	92 50	10	92 60
						$2,259 87
Incidental expenses.						
Stationery					$6 90	
Office rent					51 67	
Postage and telegraph					5 56	
Miscellaneous					176 00	
						240 13
						$2,500 00

TABLE No. 1 — (*Continued*).

EXAMINATIONS AND MAPS — OSWEGO CANAL.

Chapter 726, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
H. T. Beach	Engineer Board of Claims	101	$10 00 per day	$1,010 00	$16 58	$1,026 58
D. C. Strong	Chainman	7	2 50 per day	17 50	....	17 50
						$1,044 08
Incidental expenses.						
Labor						8 00
						$1,052 08

EXAMINATIONS AND MAPS — BLACK RIVER CANAL.

Chapter 726, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary	Travel.	Total.
A. C. Driscoll	Assistant engineer in charge	5	$6 00 per day	$30 00	$21 54	$51 54
C. E. Phelps	Surveyor Board of Claims	4	4 00 per day	16 00	2 00	18 00
C. E. Phelps	Chainman	52	2 50 per day	180 00	....	180 00
Robert Reedy	Chainman	34	2 50 per day	85 00	2 93	87 93
F. N. Phelps	Chainman	34	2 50 per day	85 00	....	85 00
Christopher Short	Chainman	34	2 50 per day	85 00	2 93	87 93
F. A. Thurston	Chainman	26	2 50 per day	65 00	....	65 00
E. Styring	Leveler	2	4 50 per day	9 00	....	9 00
						$534 40
Incidental expenses.						
Miscellaneous						30 55
						$564 95

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — SURVEYS STATE BOARD OF CLAIMS — OSWEGO CANAL.

Chapter 726, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
H. T. Beach	Engineer Board of Claims	11	$10 00 per day	$110 00	....	$110 00

EXTRAORDINARY REPAIRS — SURVEYS STATE BOARD OF CLAIMS — BLACK RIVER CANAL.

Chapter 726, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. R. Stuart	Division engineer	....	$2,400 00 per year	$13 15	$12 55	$25 70
C. E. Phelps	Chainman	26	2 50 per day	65 00	....	65 00
F. N. Phelps	Chainman	26	2 50 per day	65 00	....	65 00
Christopher Short	Chainman	26	2 50 per day	65 00	....	65 00
Robt. J. Reedy	Chainman	26	2 50 per day	65 00	....	65 00
F. A. Thurston	Chainman	26	2 50 per day	65 00	....	65 00
						$350 70
Incidental expenses.						
Office rent					$54 00	
Postage and telegraph					10	
Miscellaneous					28 00	
						88 10
						$438 80

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — IMPROVING THE OSWEGO CANAL.

Chapter 119, *Laws of* 1893.

NAME.	Rank.	Number of days	Rate of compensation	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$59 18	$8 67	$67 85
George A. Morris	Resident engineer	....	2,000 00 per year	21 91	29 90	51 81
A. C. Driscoll	Assistant engineer in charge	5	6 00 per day	30 00	4 45	34 45
E. A. Lamb	Rodman	9	3 50 per day	31 50	....	31 50
B. F. Bauder	Chainman	2	4 00 per day	8 00	3 95	11 95
Ed. J. Berry	Chainman	4	2 50 per day	10 00	3 95	13 95
J. J. Schmid	Chainman	4	2 50 per day	10 00	3 95	13 95
L. Kavanagh	Chainman	2	2 50 per day	5 00	3 95	8 95
						$234 41
	Incidental expenses.					
Miscellaneous						3 00
						$237 41

EXTRAORDINARY REPAIRS — COMPLETION OF PIER AND BREAKWATER AT CANANDAIGUA.

Chapter 173, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$32 93	$12 90	$45 83
A. C. Driscoll	Assistant engineer in charge	2	6 00 per day	12 00	4 11	16 11
Theo. A. Hendrickson	Leveler	38	4 50 per day	171 00	2 94	173 94
						$235 88
	Incidental expenses.					
Miscellaneous						10 17
						$246 05

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — MAPS AND MONUMENTS.

Chapter 358, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Edwin Styring	Leveler	19	$4 50 per day	$85 50	$4 38	$89 88
Incidental expenses.						
Miscellaneous						80
						$90 68

EXTRAORDINARY REPAIRS — REMOVING OBSTRUCTIONS, FOOT OF CAYUGA LAKE.

Chapter 279, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$38 36	$9 65	$48 01
A. C. Driscoll	Assistant engineer in charge	7	6 00 per day	42 00	6 72	48 72
Edwin Styring	Leveler	1	4 50 per day	4 50	3 74	8 94
B. F. Bauder	Chainman	2	4 00 per day	8 00	4 64	12 68
Ed. J. Perry	Chainman	1	2 50 per day	2 50	2 48	4 98
Ed. J. Perry	Chainman	2	3 50 per day	7 00	4 98	11 98
Wm. Rowlands	Chainman	1	2 50 per day	2 50	2 48	4 98
L. Kavanagh	Chainman	14	2 50 per day	35 00	5 72	40 72
J. J. Schmid	Chainman	6	2 50 per day	15 00	2 48	17 48
						$197 79
Incidental expenses.						
Miscellaneous						3 75
						$201 54

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — CONSTRUCTING A DRAIN AT WHITESBORO.

Chapter 359, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Edwin Styring	Leveler	2	$4 50 per day	$9 00	....	$9 00
Paul L. Schultze	Leveler	4	4 50 per day	18 00	$10 46	28 46
E. A. Lamb	Rodman	1	3 50 per day	3 50	....	3 50
Wm. Rowlands	Chainman	1	2 50 per day	2 50	2 66	5 16
John Schimmel	Chainman	4	2 50 per day	10 00	20	10 20
						$56 32
Incidental expenses.						
Miscellaneous					$1 00	
Postage and telegraph					25	1 25
						$57 57

EXTRAORDINARY REPAIRS — LIFT-BRIDGE OVER ERIE CANAL AT GEDDES STREET, SYRACUSE.

Chapter 385, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. C. Driscoll	Assistant engineer in charge	1	$6 00 per day	$6 00	$0 20	$6 20
Edwin Styring	Leveler	1	4 50 per day	4 50	20	4 70
E. A. Lamb	Rodman	7	3 50 per day	24 50	....	24 50
Ed. J. Berry	Chainman	1	2 50 per day	2 50	20	2 70
Wm. Rowlands	Chainman	1	2 50 per day	2 50	20	2 70
						$40 80

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — VERTICAL WALL BETWEEN GILBERT AND TURNER STREETS, UTICA.

Chapter 423, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$5 48	$2 66	$8 14
A. C. Driscoll	Assistant engineer in charge	4	6 00 per day	24 00	8 22	32 22
P. L. Schutze	Leveler	2	4 50 per day	9 00	30	9 30
E. A. Lamb	Rodman	2	3 50 per day	7 00	....	7 00
Ed. J. Berry	Chainman	1	2 50 per day	2 50	....	2 50
J. J. Schmid	Chainman	3	2 50 per day	7 50	7 38	14 88
Wm. Rowlands	Chainman	2	2 50 per day	5 00	4 38	9 38
						$83 42
	Incidental expenses.					
Miscellaneous						55
						$83 97

EXTRAORDINARY REPAIRS — PROTECTING BERME BANK OF CAYUGA AND SENECA CANAL AT GENEVA.

Chapter 424, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$59 18	$5 77	$64 95
G. A. Morris	Resident engineer	....	2,000 00 per year	65 76	21 32	87 08
A. C. Driscoll	Assistant engineer in charge	7	6 00 per day	42 00	8 65	50 65
Ed. J. Berry	Chainman	6	2 50 per day	15 00	7 18	22 18
L. Kavanagh	Chainman	3	2 50 per day	7 50	5 68	13 18
Wm. Rowlands	Chainman	3	2 50 per day	7 50	6 68	14 18
Jno. J. Schmid	Chainman	1	2 50 per day	5 00	....	5 00
						$257 25
	Incidental expenses.					
Miscellaneous						2 60
						$259 85

TABLE No. 1—(*Continued*).

EXTRAORDINARY REPAIRS — ROAD-BRIDGE OVER NEW CHANNEL, BUTTERNUT CREEK.

Chapter 470, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. C. Driscoll	Assistant engineer in charge	2	$6 00 per day	$12 00	$0 50	$12 50
B. F. Bauder	Chainman	4	4 00 per day	16 00	4 50	20 50
Ed. J. Berry	Chainman	2	2 50 per day	5 00	3 00	8 00
J. J. Schmid	Chainman	1	2 50 per day	2 50	50	3 00
Wm. Rowlands	Chainman	2	2 50 per day	5 00	1 00	6 00
						$50 00

EXTRAORDINARY REPAIRS — CLEANING MADISON BROOK FEEDER, LEBANON FEEDER AND SUMMIT LEVEL OF CHENANGO CANAL.

Chapter 570, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$39 45	$12 58	$52 03
George A. Morris	Resident engineer	....	2,000 00 per year	16 44	5 00	21 44
A. C. Driscoll	Assistant engineer in charge	14	6 00 per day	84 00	14 81	98 81
Edwin Styring	Leveler	4	4 50 per day	18 00	....	18 00
Theo. A. Hendrickson	Leveler	12	4 50 per day	54 00	14 06	68 06
B. F. Bauder	Chainman	1	4 00 per day	4 00	....	4 00
Ed. J. Berry	Chainman	6	2 50 per day	15 00	....	15 00
Fred. J. Wagner	Chainman	11	2 50 per day	27 50	37 76	65 26
Wm. Rowlands	Chainman	6	2 50 per day	15 00	13 46	28 46
J. J. Schmid	Chainman	22	2 50 per day	55 00	30 81	85 81
L. Kavanagh	Chainman	8	2 50 per day	20 00	23 02	43 02
						$499 39
Incidental expenses.						
Miscellaneous					$34 34	
Postage and telegraph					30	
						34 64
						$531 03

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — REBUILDING LOCKS ON BLACK RIVER CANAL.

Chapter 572, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$54 79	$56 25	$111 04
A. C. Driscoll	Assistant engineer in charge	8	6 00 per day	48 00	5 66	53 66
Edwin Styring	Leveler	1	4 50 per day	4 50	....	4 50
Ed. J. Berry	Chainman	7	2 50 per day	17 50	7 26	24 76
Wm. Rowlands	Chainman	4	2 50 per day	10 00	5 56	15 56
						$209 52
Incidental expenses.						
Miscellaneous						70
						$210 22

EXTRAORDINARY REPAIRS — IMPROVING CAYUGA AND SENECA CANAL AT SENECA FALLS.

Chapter 572, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$3,400 00 per year	$13 15	$1 68	$14 83
A. C. Driscoll	Assistant engineer in charge	2	6 00 per day	12 00	1 44	13 44
Edwin Styring	Leveler	5	4 50 per day	22 50	1 44	23 94
						$57 21
Incidental expenses.						
Miscellaneous						50
						$57 71

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — DREDGING CAYUGA LAKE INLET AT ITHACA.

Chapter 656, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$5 48	$2 70	$8 18
B. F. Bauder	Chainman	12	4 00 per day	48 00	1 75	49 75
J. J. Schmid	Chainman	5	2 50 per day	12 50	16 20	28 70
						$86 63
Incidental expenses.						
Postage and telegraph					$0 31	
Miscellaneous					3 50	
						3 81
						$90 44

EXTRAORDINARY REPAIRS — SLUICE TO SPILLWAY AT NORTH LAKE RESERVOIR.

Chapter 726, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$46 03	$21 26	$67 29
George A. Morris	Resident engineer	....	2,000 00 per year	21 93	22 01	43 93
A. C. Driscoll	Assistant engineer in charge	12	6 00 per day	72 00	24 00	96 10
Jay Capron	Chainman	9	5 00 per day	45 00	4 88	49 88
Chauncey Hulburt	Chainman	12	2 50 per day	30 00	4 48	34 48
						$291 18
Incidental expenses.						
Miscellaneous					$0 10	
Postage and telegraph					75	
						85
						$292 03

TABLE NO. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — CLEANING STATE DITCH AT LIVERPOOL.

Chapter 119, *Laws of* 1893.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,400 00 per year	$54 79	$11 36	$66 15
A. C. Driscoll	Assistant engineer in charge	9	6 00 per day	54 00	37 40	91 40
B. F. Bauder	Chainman	26	4 00 per day	104 00	38 76	142 76
Ed. J. Berry	Chainman	6	2 50 per day	15 00	9 00	24 00
Wm. Rowlands	Chainman	6	2 50 per day	15 00	4 50	19 50
J. J. Schmid	Chainman	2	2 50 per day	5 00	1 50	6 50
L. Kavanagh	Chainman	12	2 50 per day	30 00	8 50	38 50
Fred J. Wagner	Chainman	2	2 50 per day	5 00	6 66	11 66
						$400 47
Incidental expenses.						
Miscellaneous						5 70
						$406 17

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — FORESTPORT RESERVOIR DAM.

Chapters 494, 496, *Laws of* 1892, 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$263 03	$5 50	$268 55
George A. Morris	Resident engineer	....	2,000 00 per year	87 67	37 42	125 09
A. C. Driscoll	Assistant engineer in charge	8	6 00 per day	48 00	23 08	71 08
John R. Kaley	Assistant engineer	4	6 00 per day	24 00	....	24 00
Paul L. Schultze	Leveler	73	4 50 per day	328 50	27 96	356 46
Theodore A. Hendrickson	Leveler	16	4 50 per day	72 00	50	72 50
E. A. Lamb	Rodman	3	3 50 per day	10 50	....	10 50
C. K. Monroe	Chainman	52	4 00 per day	208 00	....	208 00
B. F. Bauder	Chainman	5	4 00 per day	20 00	....	20 00
E. J. Berry	Chainman	26	2 50 per day	65 00	16 39	109 39
		8	3 50 per day	28 00		
William Rowlands	Chainman	57	2 50 per day	142 50	....	143 50
John Schimmel	Chainman	74	2 50 per day	185 00	....	185 00
L. Kavanagh	Chainman	22	2 50 per day	55 00	4 39	59 39
H. J. Richardson	Chainman	5	2 50 per day	12 50	....	12 50
Fred. J. Wagner	Chainman	1	2 50 per day	2 50	....	2 50
J. J. Schmid	Chainman	17	2 50 per day	42 50	....	42 50
						$1,709 93
Incidental expenses.						
Office rent					$21 00	
Postage and telegraph					21 65	
Miscellaneous					179 22	
Stationery					68 20	
						290 07
						$2,000 00

TABLE No. 1 — (*Continued*).

EXTRAORDINARY REPAIRS — SURVEYS ON ACCOUNT OF ATTORNEY-GENERAL — ERIE CANAL.

Chapter 358, *Laws of* 1894.

NAME.	Rank.	Number of days	Rate of compensation.	Salary.	Travel.	Total.
A. C. Driscoll	Assistant engineer in charge	5	$6 00 per day	$30 00	$8 97	$38 97
Edwin Styring	Leveler	3	4 50 per day	13 50	3 72	17 22
Ed. J. Berry	Chainman	6	2 50 per day	15 00	3 72	18 72
William Rowlands	Chainman	2	2 50 per day	5 00	2 54	7 54
						$82 45
Incidental expenses.						
Postage and telegraph					$0 25	
Miscellaneous					7 65	
						7 90
						$90 35

EXTRAORDINARY REPAIRS — SURVEYS ON ACCOUNT OF ATTORNEY-GENERAL — OSWEGO CANAL.

Chapter 358, *Laws of* 1894.

NAME.	Rank.	Number of days	Rate of compensation.	Salary.	Travel.	Total.
H. T. Beach	Engineer Board of Claims	41	$10 00 per day	$410 00	$5 70	$415 70
Incidental expenses.						
Miscellaneous						25
						$415 95

TABLE NO 1 — (*Concluded*).

EXTRAORDINARY REPAIRS — SURVEYS ON ACCOUNT OF ATTORNEY-GENERAL — BLACK RIVER CANAL.

Chapter 358, *Laws of* 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. C. Driscoll	Assistant engineer in charge	14	$6 00 per day	$84 00	$11 64	$95 64
Edwin Styring	Leveler	47	4 50 per day	211 50	....	211 50
E. A. Lamb	Rodman	2	3 50 per day	7 00	....	7 00
Fred. J. Wagner	Chainman	23	2 50 per day	57 50	....	7 50
						$371 64
Incidental expenses.						
Miscellaneous						17 38
						$389 02

SUMMARY.

ITEMS.	Authorized by — Chap.	Authorized by — Year.	Amount.	Total.
ORDINARY REPAIRS.	89	1893		
Erie canal	......	......	$7,931 01	
Oswego canal	......	......	353 82	
Black River canal	......	......	3,081 04	
Cayuga and Seneca canal	......	......	19 73	$11,385 60
EXTRAORDINARY REPAIRS.				
Erie Canal.				
Lift-bridge at Mulberry street, Syracuse	610	1892	$161 74	
Improving channel of Butternut creek	119	1893	471 66	
Sewer at Canastota	328	1893	705 86	
Bridge at South James street, Rome	562	1893	200 00	
Lift-bridge at Clinton street, Syracuse	57	1893	1,200 00	
Reconstructing highway across head of Owagena lake	568	1893	173 20	
Completion of highway across head of Owagena lake	335	1894	265 74	
Lift and fixed bridges at Genesee street, Utica	560	1893	2,500 00	
Constructing a drain at Whitesboro	259	1894	57 57	
Lift-bridge over Erie canal at Geddes street, Syracuse	335	1894	40 80	
Vertical wall between Gilbert and Turner streets, Utica	428	1894	83 97	
Road bridge over new channel, Butternut creek	470	1894	50 00	
Surveys on account of Attorney-General	353	1894	90 35	6,000 39
Oswego Canal.				
Stone dam at Baldwinsville	113	1893	$1,709 19	
Examinations and maps	726	1893	1,052 08	
Surveys State Board of Claims	726	1893	110 00	
Improving the Oswego canal	119	1893	287 41	
Cleaning State ditch at Liverpool	119	1893	406 17	
Surveys on account of Attorney-General	358	1894	415 95	3,980 80
Black River Canal.				
Rebuilding lock No. 76	119	1893	$315 94	
Examinations and maps	726	1893	564 95	
Surveys State Board of Claims	726	1893	433 80	
Rebuilding locks on Black River canal	572	1894	210 22	
Forestport reservoir dam	494 496	1892 1894	2,000 00	
Surveys on account of Attorney-General	358	1894	389 02	3,918 93
Cayuga and Seneca Canal.				
Protecting berme bank of Cayuga and Seneca canal at Geneva	424	1894	$259 85	
Improving Cayuga and Seneca canal at Seneca Falls	572	1894	52 71	
Dredging Cayuga lake inlet at Ithaca	656	1894	90 44	403 00
Miscellaneous.				
Raising dam on Beaver river at Stillwater	469	1893	$700 00	
Bridge over Twitchell creek	224	1893	131 00	
Clearing flowed ground at Stillwater	119	1893	184 88	
Completion of pier and breakwater at Canandaigua	178	1894	246 00	
Maps and monuments	353	1894	90 68	
Removing obstructions foot of Cayuga lake	279	1894	201 54	
Cleaning Madison brook feeder, Lebanon feeder and Summit level of Chenango canal	570	1894	534 08	
Sluice to spillway at North Lake reservoir	726	1894	292 08	2,330 11
Total abstracts rendered during fiscal years 1893 and 1894				$27,908 83

Amount disbursed by R. R. Stuart from October 1, 1893, to January 22, 1894	$12,077 65
Amount disbursed by W. H. H. Gere from January 23, 1894, to September 30, 1894	15,831 18
Total	$27,908 83

TABLE No. 2.

Statement of Contracts in force October 1, 1894.

Names of Contractors.	Date of contract.	Character of work.	Act.		Appropriation.	Engineer's estimate.	Engineer's estimate at contract price.	Payment to Sept. 30.
			Chapter.	Year.				
Hughes Bros & Bangs	Aug. 14, 1893	Stone dam at Baldwinsville	1 8 130	1893 1894	$35,000 00 25,000 00	$60,000 00	$54,079 00	$22,695 00
Hilton Bridge Construct'n Co.	Nov. 15, 1893	Two lift and one fixed bridge over Erie canal at Utica	560	1893	*45,000 00	....	....	36,6 0 00
A. C. Hall	Sept. 11, 1894	Sluice in North Branch reservoir	726	1893	8,500 00	7,993 60	6,593 60	....
A. Van Wagner & Co.	July 28, 1894	Lock No. 18, Black River canal	572	1894	....	18,837 50	17,037 50	....
Mulcahy & Co.	July 2', 1894	Lock No. 28, Black River canal	572	1894	....	17,770 50	15,970 50	....
Mulcahy & Co.	July 28, 1894	Lock No 37, Black River canal	572	1894	....	17,094 00	15,294 00	....
J. J. Hallock	Aug. 23, 1894	Removing obstructions from Cayuga lake	279	1894	4,000 00	4,000 00	3,200 00	....
Brayer & Albaugh	Oct. 5, 1894	Protecting berme bank of Cayuga and Seneca canal at Geneva.	424	1894	15,000 00	13,858 50	11,685 00	....
Hingston & Woods	Aug. 23, 1894	Removing bars and dredging channel of Cayuga inlet	234 656	1892 1894	5,000 00 5,000 00	5,000 00	4,250 00	....
Edward S. Candee	Sept. 27, 1894	Repairs to Madison and Lebanon feeders	570	1894	10,000 00	9,921 44	7,608 70	....

* City of Utica appropriated $15,000 of this sum.

TABLE No. 3.

STATEMENT OF CONTRACTS COMPLETED AND SETTLED DURING THE YEAR.

NAMES OF CONTRACTORS.	Date of contract.	Character of work.	Act.		Appropriation.	Engineer's estimate at contract prices.	Amount of final account.
			Chapter.	Year.			
W. H. Shepard & Sons	Aug. 3, 1892	Wrought-iron bridge superstructure at Rome	601	1893	$5,000 00	$3,800 00	$3,835 08
Brumelkamp & Lane	Apr. 14, 1893	Substructure, Mulberry street bridge, Syracuse	610	1892	*14,000 00	2,144 00	2,283 07
W. H. Shepard & Sons	Apr. 20, 1893	Superstructure, Mulberry street bridge, Syracuse	610	1893		8,700 00	9,446 72
W. H. Eldridge	Aug. 18, 1893	Raising approaches Seneca street bridge, Weedsport	161	1893	1,000 00	810 00	776 40
W. J. Cramond	Sept. 25, 1893	Bridge over old abandoned canal at Rome	562	1893	2,370 00	1,799 20	1,911 81
A. D. Osborne	Nov. 9, 1893	Brick sewer at Canastota	328	1893	7,000 00	7,000 00	6,338 81
Pidgeon & Co	Jan. 29, 1894	Substructure hoist-bridge, Clinton street Syracuse	57	1893	14,000 00	2,900 00	5,406 26
Wrought Iron Bridge Co	Feb. 23, 1894	Superstructure hoist-bridge, Clinton street, Syracuse	57	1893		7,000 00	7,971 60
Hughes Bros	Jan. 24, 1893	Spillway at Eaton Brook reservoir	471	1892	17,000 00	18,135 00	12,087 71
J. J. Hallock	Apr. 4, 1893	Lock No. 76, Black River canal	119	1893	17,000 00	13,535 00	12,706 69
F. Louis Faas	Sept. 6, 1892	Raising dam on Beaver river at Stillwater	469	1892	15,500 00	13,220 00	11,734 17
Beckwith & Quackenbush	July 26, 1892	Completion of reservoir dam at Forestport	494	1892	35,000 00	30,780 00	27,952 31
Edward S. Candee	Aug. 14, 1893	Highway at head of Owagena lake	658	1893	6,000 00	4,861 50	4,990 39
Edward S. Candee	July 21, 1894	Completing at head of Owagena lake	335	1894	6,000 00	4,857 50	4,391 50
John E. Pidgeon	Nov. 9, 1893	Improving channel of Butternut creek	119	1893	9,000 00	9,000 00	6,796 35
Edward S. Candee	July 21, 1894	Highway bridge over Butternut creek	470	1894	1,000 00	1,000 00	869 42
James Robinson	July 2[illegible], 1894	Completion of pier and breakwater at Canandaigua lake	173	1894	2,500 00	1,985 00	1,794 11
Edward S. Candee	July 21, 1894	Cleaning State ditch at Liverpool	119	1893	5,000 00	3,600 00	3,347 14

* City of Syracuse appropriated $7,000 of this sum.

TABLE No. 4.

WATER RECORD OF CAYUGA AND CROSS LAKES AND SENECA RIVER, AS PER CONCURRENT RESOLUTION OF 1884.

(Water surface given below datum line.)

LOCATION.	Bench-mark number.	Miles from Cayuga lock.	1884. August 5, 6 and 7. Water. Surface.	1884. August 5, 6 and 7. Water. Depth.	1884. December 2, 3 and 4. Water. Surface.	1884. December 2, 3 and 4. Water. Depth.	1885. March 4, 5, 6 and 7. Water. Surface.	1885. March 4, 5, 6 and 7. Water. Depth.	1885. August 6 and 7. Water. Surface.	1885. August 6 and 7. Water. Depth.	1885. December 2, 3 and 4. Water. Surface.	1885. December 2, 3 and 4. Water. Depth.
Cayuga lake	1	0	— 8.59	10.49	—10.11	8.97	—10.09	9.08	— 9.38	9.75	— 8.78	10.80
Mud lock	2	1½	— 8.80	10.43	—10.22	9.00	—10.17	9.05	— 9.54	9.68	— 8.91	10.81
Canandaigua river, south of canal	..	6½	—11.20	5.60	—12.68	4.00	—12.54	4.60	—11.98	5.20	—11.09	6.10
Aqueduct	3	6½	—11.42	7.08	—12.98	5.47	—12.66	5.70	—12.19	6.90	—11.26	7. 0
Canandaigua river, north of canal	......	6½	—11.58	5.40	—13.01	4.00	—12.83	4.90	—12.48	5.20	—11.48	6.20
West Shore railroad crossing	4	9	—11.85	8.75	—13.20	2.40	—13.70	2.80	—12.88	2.60	—11.48	3.60
			....	7.80	....	6.50	....	7.70	....	7.50	....	8.50
N. Y. C. and H. R. R. R. crossing	5	10	—12.41	4.80	—14.19	3.00	—13.48	3.90	—13.48	3.90	—12.66	4.70
Mosquito point	6	15¼	—15.93	0.10	—16.81	*	—16.70	*	—16.04	*	—14.28	1.80
			....	7.50	....	6.80	....	6.40	....	7.10	....	8.90
Cross lake	7	25	—17.33	19.20	—17.55	19.00	—18.00	18.50	—17.85	18.70	—15.88	21.10

* Above water.

TABLE NO. 4 — WATER RECORD OF CAYUGA AND CROSS LAKES AND SENECA RIVER, ETC. — (*Continued*).

LOCATION.	1886.						1887.						1888.					
	MARCH 8 AND 9.		AUGUST 5, 6 AND 7		DECEMBER 7.		MARCH 4.		AUGUST 5.		DECEMBER 2.		MARCH 3.		AUGUST 6.		DECEMBER 3 AND 4.	
	WATER.		WATER.		WATER.		WATER.		WATER.		WATER.		WATER.		WATER.		WATER.	
	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.
Cayuga lake	— 8.11	10.97	— 8 49	10.59	— 8.38	10.75	— 6.82	12 39	— 8.23	10.86	— 9.75	9 33	— 9.00	10.08	— 8.88	10.20	— 9.28	9.80
Mud lock	— 8.26	10.96	— 8.76	10.40	— 8.46	10.76	— 6.82	12.40	— 8.35	10.87	— 9.97	9.25	— 9.11	10.11	— 9.09	10.18	— 9.48	9.74
Canandaigua river, south of canal	— 9.61	7.60	—11.88	5.40	—10.20	7.00	— 7.89	9 80	—10.87	6.80	.....	.....	—10 14	7.00	—11.43	5.7	—10.66	6.5
Aqueduct	— 9.72	8.70	—12.12	6.30	—10.35	8.10	— 8.14	10.30	—11.09	7.30	—12.43	6.00	—10.26	8 1	—11.63	6.8	—10.84	7.6
Canandaigua river, north of canal	— 9 93	7.80	—12.24	5.40	—10.59	7.10	— 8.30	9.40	—11.51	6.20	—12.64	5.1	—10.57	7.2	—11.98	5.7	—11.12	6.6
W. S. R. R crossing	—10.24	5.20	—12.76	2.70	—10.79	4.50	— 8.82	6.70	—12.00	3.50	—12.91	2.6	—10.95	4.5	—12.29	3.3	—11.35	4.1
	....	10.50	.....	7.61	....	9.40	....	11.60	.....	8.40	....	7.5	....	9.4	....	8.1	....	9.0
N. Y. C. and H. R. R. R crossing	10.74	6.60	—13.31	4.00	—11.61	5.70	— 9.18	8.10	—13.55	4.80	—13.67	3.7	—11.45	5.9	—13.00	4.4	13.19	5.2
Mosquito point	—12.15	4.00	—16.26	*	—13.39	2.60	—10.52	5.50	—15.41	0.60	—16.57	*	—13.22	2.8	—15.63	0.4	—14.69	1.3
	....	11.00	....	7.00	....	9.70	....	12.60	....	7.70	....	6.5	....	9.9	....	7.5	....	8.4
Cross lake	—14.01	22.50	—17.71	18 20	—15.39	21.10	—12.09	24.40	—17.17	19.30	—17.43	19.1	—14.53	2.2	—17.40	19.1	—14.83	21.67

* Above water.

TABLE NO. 4 – WATER RECORD OF CAYUGA AND CROSS LAKES AND SENECA RIVER, ETC.—(*Continued*).

LOCATION.	1889.						1890.					
	MARCH 5 AND 6.		AUGUST 5.		DEC. 4 AND 5.		MARCH 6 AND 7.		AUGUST 8.		DEC. 4 AND 5.	
	WATER.		WATER.		WATER.		WATER.		WATER.		WATER.	
	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.
Cayuga lake	— 8 93	10.15	— 6.92	12.16	— 6.56	12.52	— 7.41	11.67	— 7.47	11.61	— 7.46	11.63
Mud lock	— 9.04	10.18	— 7.03	12.22	— 6.96	12.26	— 7.55	11.67	— 7.67	11.55	— 7.60	11.62
Canandaigua river, south of canal	— 9.58	7.26	— 8.83	8.3	— 8.29	8.8	— 8.92	8.2	—10.51	6.6	— 9.46	7.7
Aqueduct	—10.07	8.29	— 9.08	9.4	— 8.56	9.9	— 9.23	9.2	—10.78	7.6	— 9.79	8.6
Canandaigua river, south of canal	—10.28	7.44	— 9.38	8.4	— 8.73	9 0	— 9.27	8.4	—11.23	6.5	— 9.96	7.7
West Shore railroad crossing	—10.47	5.0	— 9.84	5.7	— 8.74	6.8	— 9.75	5.8	—11.50	4.0	—10.34	5.2
	....	9.9	....	10.6	....	11.7	....	10.7	....	8.9	....	10.1
New York Cent. and Hudson river R. R crossing	—10.97	6.4	—10.47	7 0	— 9.17	8.2	— 9.78	7.6	—12.31	5.1	—10 61	6.8
Mosquito point	—12.25	3.8	—12.92	8.1	—10.50	5.4	—10.91	5.1	—15.16	0.8	—11.33	4.7
	....	10 9	....	10.2	....	12.5	....	12.2	....	7.9	....	11.8
Cross lake	—14.13	22.4	—13.32	23.2	—11.75	24.8	—12.95	23.6	—16.23	20.3	—13.37	23.1

TABLE NO. 4 — WATER RECORD OF CAYUGA AND CROSS LAKES AND SENECA RIVER, ETC. — (*Continued*).

LOCATION.	1891.						1892.					
	MARCH 3 AND 6.		AUGUST 3 AND 4.		DEC. 9 AND 10.		MARCH 7 AND 10.		AUGUST 4.		DECEMBER 7.	
	WATER.		WATER.		WATER.		WATER		WATER.		WATER.	
	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	Surface	Depth.	Surface.	Depth.	Surface.	Depth.
Cayuga lake	— 5.69	13 19	— 8.96	10.12	— 9.52	9 56	— 8.67	10.41	— 7.69	11.39	— 9.06	10.02
Mud lock	— 5.96	13.26	— 9.27	9.95	— 9.66	9.56	— 8.79	10.43	— 7.85	11.39	— 9.33	9 89
Canandaigua river, south of canal	— 7.16	10.0	—12.69	4.4	—12.12	5.0	—10.55	6.5	— 9.56	7.5	—10.54	6 5
Aqueduct	— 7.48	10.9	—12.71	5.7	—12.30	6.1	—10.80	7.6	—11.05	7.4	—11.54	6.9
Canandaigua river, north of canal	— 7.45	10.2	—12.97	4.7	—12.46	5.2	—11.06	6.6	—11.28	6.4	—11.60	6.1
West Shore Railroad crossing	— 7.65	6.0	— 8.29	2.3	—13.66	2.9	—10.77	4.8	—11.66	4.5	—12.50	4.2
	....	12.8	....	7.1	....	7.7	....	9.6	....	8.7	....	7.9
New York Cen. and Hudson River R R crossing	— 7.84	7.9	—13.93	3.5	—13.63	3.8	—11.81	5.7	—13.12	3.3	—13.30	4.2
Mosqu'to point	— 8.64	7.4	—16.70	Bed dry	—15.47	0.5	—12.96	8 0	—14 91	1.1	—14.51	1.5
	....	14 5	....	6.4	....	7.6	....	10 1	....	8.2	....	8.6
Cross lake	—10.4	26.0	—17.48	19.0	—16.22	20.3	—13.75	23.7	—16.56	20.0	—15.61	20.9

TABLE NO. 4 — WATER RECORD OF CAYUGA AND CROSS LAKES AND SENECA RIVER, ETC. — (*Concluded*).

LOCATION.	1893.						1894.				Remarks.
	MARCH 3 AND 4.		AUGUST 7 AND 8.		DECEMBER 6 AND 7.		MARCH 6 AND 7.		AUGUST 7 AND 8.		
	WATER.		WATER.		WATER.		WATER		WATER.		
	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	
Cayuga lake	— 9.46	9.63	— 8.39	10.78	—10.01	9 1	— 9.04	10.58	— 7.66	11.70	Depth on lock miter-sill.
Mud lock.	— 9.55	9 67	— 8.63	10.60	—10 14	9.85	— 8 99	10.79	— 7.87	11.40	Depth on miter-sill.
Canandaigua river, south of canal	—10.84	6.3	—11.190	5.8	—12.19	5.20	— 9.84	7.90	—10.33	6.00	Depth of river.
Aqueduct	—11.19	7.2	—11.95	6.5	—13.25	5.40	— 9.60	7.40	—10 95	6.50	Depth on aqueduct foundation.
Canandaigua river, north of canal	—11.85	6 3	—12.00	5 7	—13 27	5 00	— 9.77	8.80	—11.19	5 10	Depth of river.
West Shore railroad crossing..	—11.71	3.8	—12.42	3.1	—13.29	4.95	— 9.76	8.50	—11.79	4 90	Depth on natural bed.
	....	8.7	....	8.0	....	9.70	....	10.60	....	8.90	Depth in channel dredged.
New York Central and Hudson River railroad crossing	—12.43	5.0	—13.13	4 3	—13.96	6.70	—10.25	10.40	—12 50	6.50	Depth on bridge foundation.
Mosquito point................	—14.48	1.5	—15.280	0.6	—16.05	Bed dry.	—11.94	5.30	—14.22	Edge.	Depth on natural bed.
	....	8.6	....	7.7	....	6.1	....	11.40	....	8.0	Depth in channel dredged.
Cross lake	—15.78	20.7	—17.04	19.5	—16.76	18.6	—12.66	3.27	—16 84	0.4	Depth at iron bridge.

APPENDIX D.

REPORT

OF THE

DIVISION ENGINEER

OF THE

WESTERN DIVISION

FOR THE

YEAR ENDING SEPTEMBER 30, 1894.

APPENDIX D.

ROCHESTER, *December* 18, 1894.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor:*

SIR.—I have the honor of submitting to you my report on the western division of the State canals for the fiscal year ending September 30, 1894:

The canal slips and navigable feeders are as follows:

	Miles.
Erie canal, from the east line of Wayne county to Hamburg street, in the city of Buffalo	148.92
Five slips in the city of Buffalo, aggregate length	1.60
Genesee river feeder, in the city of Rochester	2.25
Total	152.77

Unnavigable feeders:

	Miles.
Tonawanda and Oak Orchard	11.55
Genesee Valley canal, from Cuba reservoir to lock 87, Rockville	7.65
Genesee Valley canal, from Scottsville to Rochester Rapids dam	11.00
Total	30.20

The sources of water supply for the Erie canal are as follows:

1. Lake Erie, at Buffalo.

2. Tonawanda creek, at Pendleton.

3. Tonawanda and Oak Orchard creek, at Medina.

4. Allen's creek, through the Genesee Valley canal and Genesee river feeder, from Scottsville to Rochester; this water

is connected from Valley canal by pipe across river to the feeder below the Rapids dam, and thence into the canal.

5. The Cuba reservoir, in Allegany county, through the Genesee Valley canal and the Genesee river to Rochester, and through the Genesee river feeder in the city of Rochester, into the canal. The Tonawanda and Oak Orchard feeder and the Genesee river assist in filling the canal in the spring; the water from Allen's creek, at Scottsville, which is taken into the feeder at Rochester, tends to keep the water in the feeder pure through the summer months.

Since care has been taken to use as little water as possible below Newark, in locking boats, no difficulty has been experienced in keeping up the levels at the lower end of the division.

Dams.

There are six dams on the division, as follows:

1. One across Tonawanda creek, near its mouth; it raises the waters in the creek about four feet above the level of Niagara river.

2. One across the same creek, south of Medina; its purpose is to turn the waters of the creek into the feeder, and through it into the channel of Oak Orchard creek, and from thence into the canal at Medina.

3. One across Allen's creek, in the village of Scottsville, to send the water through the Genesee Valley canal, which is now used as a feeder from Scottsville to Rochester.

4. One across the Genesee river at Rochester, to turn the water of that stream into the feeder.

5. One across Oil creek, near the village of Cuba, Allegany county, to hold the waters of that creek and form a reservoir; it is composed of earth, faced with riprap and slope wall, and is 2,200 feet long and 65 feet in height, where it crosses the stream.

6. One across a valley, two miles from the last-mentioned one; it has a waste-weir, composed of stone, to serve as an escape for the waters of the creek when the reservoir is full.

Locks.

There are 23 locks on this division, and all lock down toward tide-water:

No.	Location.	Lift in feet.
53.	One and one-fourth miles west of Clyde (lengthened),	4.755
54.	At Lock Berlin (lengthened)	7.360
55.	In the village of Lyons (lengthened)	6.251
56.	Poorhouse, one and seven-tenths miles west of Lyons (lengthened)	9.848
57.	Lower lock at Lockville, near Newark (not lengthened)	8.028
58.	Middle lock at Lockville, near Newark (not lengthened)	8.004
59.	Upper lock at Lockville, near Newark (not lengthened)	8.002
60.	Eight-tenths of a mile east of Macedon (lengthened),	9.886
61.	In the village of Macedon (lengthened)	6.601
62.	Two and one-quarter miles west of Pittsford (lengthened)	8.807
63.	Miller's lock, in the village of Brighton (lengthened),	8.719
64.	Sipples' lock, in the village of Brighton (lengthened),	10.108
65.	Reservoir lock, in the city of Rochester (lengthened),	10.102
66.	First lock, in the city of Rochester (lengthened)...	8.859
67-71.	Five combined locks at Lockport (not lengthened),	57.427
	One guard-lock at Sulphur Springs; it has one chamber, 110 x 20 feet, and two additional head-gates. These gates are closed when a flood occurs in Tonawanda creek; otherwise they are left open.	
	One river lock at Tonawanda, connecting the Niagara river with canal; the lift is generally four feet, depending on height of water in river.	
	One double chamber-guard and lift-lock, lengthened at Black Rock (No. 72); it is 112 x 20 feet. The lift together with the fall in the harbor from canal below the mean low waters in the lake is......	2.425
	Total	175,182

		Lift in feet.
By adding to the above lifts the surface descent on the different levels, we get the total descent on the division:		
On Montezuma level	.196	
On Twelve-mile level, Nos. 59 to 60..........	.165	
On Seventeen-mile level, Nos. 61 to 62.......	.343	
On Three-mile level, Nos. 62 to 63............	.063	
On Long level, Rochester to Lockport, Nos. 66 to 67	3.165	
On level between Lockport and Black Rock..	1.239	
		5.171
Total rise going west		180.353

There is also one single chamber ship-lock from Black Rock harbor to Niagara river; it is 200 x 36 feet. The lift is usually four feet, according to the height of water in the lake and river. The weigh-lock, in the city of Rochester, not used as such for some years.

Repairs to Locks.

New tumble-gate platforms, wedges and wedge-caps, together with new tumble-gates have been inserted at head of locks 57 and 59, with repairs to masonry and lock bottom.

Lower gates and miter-sills were renewed in locks 56 and 57.

New balance-beams have been placed (four) on gates on lock 59; two on lock 57 and two on lock 56. All of the lock masonry was repointed where necessary and new bottoms in chambers were inserted in portion of locks 53 and 56.

Upper miter-sill, upper gates with paddles renewed. Towpath hollow quoin recut. Chamber bottom partially taken up and grouted in lock 62.

Upper miter-sill and foundation under dam repaired. Hollow quoin recut; upper gates and three balance-beams renewed in lock 63.

Two gates north side of lock 68, and two east end of lock 69 renewed. Old stone miter-sills replaced by white oak timber.

The bottom of chambers replanked; four balance-beams renewed and repairs made where necessary in combined lock 67 to 71, Lockport.

Balance-beams and lock-gates renewed at river lock, Tonawanda.

Miter-sill repaired and balance-beams renewed at ship-lock, Black Rock.

Repairs to Locks Needed.

New tumble-gates and new upper gates, locks 53 and 54.

New lower gates and new miter-sills, lock 60.

Protection piers to locks 63 and 64 should be partially retimbered and new miter-sills and one pair of gates require renewing.

The south wall of lock No. 71 requires to be taken down and rebuilt, recommended in last report.

Aqueducts.

The Lyons aqueduct should have new floor timbers and new planking.

The Rochester aqueduct has been leaking considerably and requires the bottom cemented and sides repointed. It is unfortunate that so fine a structure should be neglected and I respectfully request that it should be repaired before opening of navigation next spring; it has been recommended for over two years.

Bridges.

There are 109 bridges of cast iron; 56 of wrought iron; 22 of wood and iron, and 34 of wood over Erie canal. Slips 1, 2 and 3, Ohio and Commercial slips, Hamburg and Clark and Skinner canals in the city of Buffalo; and one pipe-truss over Oak Orchard Creek feeder on Batavia road, Orleans county, making a total of 223; last report, 1892, was 224. This loss of one was caused by the city of Rochester taking down the Court street truss and replacing it by an iron girder in connection with the new stone arch bridge built across the Genesee river.

No. 12. Klaus (wood) highway requires new truss, built in 1882.

No. 36, Highway (wood), requires renewal; could recommend

an iron superstructure, as considerable heavy travel pass over it. It was built in 1856 (truss sheathed) and have no knowledge of its being replaced by any other since that time; recommended in last report.

New floors have been laid on bridges Nos. 1, 2, 5, 10, 14, 16, 17, 35 and 39.

No. 44, Highway. Roadway partly replanked, one straining beam and two braces renewed.

No. 46, Main street, Fairport. Floor joists and plank renewed.

No. 47, Fullam's basin. Replaced by Whipple iron arch truss; formerly Court street, Rochester.

No. 50, Bushnell's basin. Roadway partly replanked.

No. 54, Main street, Pittsford. Roadways and sidewalks partly replanked.

No. 57, Weeds. Lower chord spliced, one end brace renewed and partly replanked.

No. 73, Swing-bridge, Rochester. Roadway partly replanked.

No. 76 1-2, Lift-bridge, Caledonia avenue, Rochester. Roadway and sidewalks partly replanked.

No. 77, Lift-bridge, West avenue, Rochester. Roadway, sidewalks and stairs replanked. New heavier bevel gearing, cross-shafts, etc., were inserted.

Nos. 43, 45, 53, 55, 56, 58, 60, 61, 63, 64, 66 and 69, roadways partly replanked.

Nos. 74, 76, 85, 99, 107 and 108, roadway and sidewalk partly replanked.

No. 78, Old Bollman bridge, Ford street, Rochester. Replaced by an iron lattice.

No. 89, Four-mile grocery. Superstructure (wood) renewed.

No. 143, Floor joists and plank renewed.

Nos. 144 and 146, Floor joists and needle-beams renewed and replanked.

No. 147, Watson's. New joists inserted and replanked.

No. 154, Wakeman's. Needle-beams renewed and replanked.

From No. 169, Pendleton, to Buffalo, are in good condition except No. 192, Mill street, Black Rock. This wooden bridge was built in 1873. It has a clear span of 113 feet and 13 feet

2 inches C. to C. of truss. It is in a dangerous condition. Most of the timbers are decayed, and has to be constantly inspected. I would recommend a wrought-iron superstructure to replace it. Pickard's bridge, No. 174, is also dangerous, and requires a new one to replace it.

Nos. 205, 206, 210 and 217 in Buffalo have been taken down and replaced by wrought-iron lattice trusses.

No. 197, Georgia street, is a Whipple iron arch truss. One roadway 20 feet between center of trusses and 178 feet clear span. There are very heavy loads of coal passing over it and I consider it unsafe. The same may be said of No. 203, Whipple iron arch, having three roadways and two sidewalks on Erie street. The clear span is 90 9-12 feet and 19 10-12 feet C. to C. of trusses. The street is nearly 100 feet in width and the bridge is the full width.

No. 194, Ferry street, Black Rock. Has had a new sidewalk put in; when first erected it had only one, and the travel to the ferry and Canada has been so extensive during summer months that the State hands put up the extra one.

No. 195, Swing-bridge in Black Rock harbor, being extension of No. 194 to the ferry, etc., is out of repair on account of the foundation settling. It will require extensive repairs.

Bridge Masonry.

No. 54, Pittsford, west wing and part of berme abutment taken down and rebuilt.

No. 178, West abutment of river lock slip, Tonawanda, taken down and rebuilt.

No. 205, North abutment of Canal street, over Commercial slip, Buffalo, taken down and rebuilt.

Culverts.

No. 128, Wings and breast-walls taken down and rebuilt, bottom taken up, grouted and replanked.

No. 33, Wings and breast-walls taken down and rebuilt.

No. 84, Composite dive. A leak occurred September 7; navigation not interrupted.

No. 95, Fish creek (two arches). A serious leak occurred through the masonry June 22; navigation suspended for 24 hours.

No. 108, Composite dive, near Williams' bridge, No. 146. A leak occurred but navigation not interrupted.

The cause of these leaks are from steamer wheels washing the material in bottom, making large holes for the water to reach the structures. I would recommend they be stripped, cleaned and concreted across prism.

A great many culverts on this division require repairs to masonry outside of prism.

Bulkheads, Waste-weirs, Etc.

The dam at head of Genesee feeder, Rochester, requires replanking.

Adams' basin, stop-gate, replanked; three new girts and tow post inserted, and part of the pier masonry relaid.

Brockport waste-weir. Towpath bridge partly replanked.

Holley stop-gate. New timbers and gates put in.

Cartersville waste-weir. Towpath bridge renewed.

Mabeis waste-weir repaired.

Vertical Walls, Etc.

Vertical wall west of bridge 16, Lyons, relaid in cement, berme side.

Vertical wall in the village of Clyde repaired where required; about 200 feet; more should be relaid.

Vertical wall south of approach to bridge 35 (towpath change) Palmyra, should be relaid. A new vertical wall (towpath side) 264 feet in length, was built under act chapter 726, Laws 1893, between South street, Paul street and Pinnacle avenue, Rochester.

An appropriation was made, act chapter 653, Laws 1894, of $2,500, for building portion of the high retaining wall between aqueduct and Court street bridge. An examination is necessary of the present wall below water, and can not be done until the water is out of the canal.

About 300 feet of vertical wall was relaid, towpath side, Middleport.

About 300 feet of slope wall was repaired, towpath side, west of Holley.

About 100 feet of vertical wall was repaired, towpath side, in Albion.

About 150 feet of vertical wall was rebuilt, foot of Porter avenue, Buffalo.

About 160 feet of vertical wall was rebuilt, foot of Bird avenue, Buffalo.

About 50 feet of vertical wall was rebuilt, near Ferry street bridge, Black Rock.

About 75 feet of vertical wall was rebuilt opposite slip No. 2, Buffalo.

About 100 feet of vertical wall was rebuilt, berme side, between Two-mile creek and Tonawanda.

About 100 feet of vertical wall was rebuilt in Commercial slip, Buffalo.

Between Pendleton and Sulphur Spring guard-lock the docking timber should be taken up and towpath raised two feet; recommended in last report.

Bird Island Pier.

A considerable portion of the old stone pier, dividing Black Rock harbor and Niagara river, between its mouth and Ferry street, has been damaged by storms and ice; many of the old cribs are decayed and will have to be replaced by new, and also stone, to properly protect the harbor; recommended in last report.

The timber crib pier, being an extension of the old one, for about 1,600 feet from the extreme or south end, requires to be protected northerly from the storms of the lake, with large stone; a rough estimate amounts to 6,000 cubic yards.

Submarine Work.

A channel 50 feet in width of rock and earth has been excavated in prism of canal, commencing 550 feet east of Hudson street bridge (196 1-2), and extends easterly to station 15, a distance of 442 feet; from station 20 to 25, 330 feet; from station

54 and 20 to 55 and 35, 81 feet; and from station 100 to 103, 198 feet, making a total distance of 1,051 lineal feet; this was done under act chapter 119, Laws of 1893, to give 10 1-2 feet of water. Under same act a channel 50 feet in width was finished in Black Rock harbor, giving 12 feet of water for a distance of 1,000 feet. Under same act a channel 100 feet from dock was completed for a distance of 388 feet in Erie basin, giving 18 feet of water.

Under act chapter 588, Laws of 1894, a channel 50 feet wide for 120 feet in length in Erie basin is progressing.

Chemung Canal and Feeder.

Under act chapter 726, Laws of 1893, and act chapter 358, Laws of 1894, work was done for the abatement of nuisances from near Elmira to Havana. This includes removal of Clinton Mill dam on Newtown creek and removal of bars; Diven's ditch straightened and deepened; prism of canal from Horseheads to Pine valley improved; same done in Millport and Havana. This work is progressing favorably.

Vertical Wall in Falls Creek, Havana.

Under act chapter 345 of Laws of 1894, a wall is being built to protect east bank of said creek.

Oak Orchard Creek and Feeder.

Under act chapter 136, Laws of 1893, the work was let on September 25, 1893, for the construction of a bulkhead in the village of Medina, and for improving the creek and feeder. The bulkhead was completed in March, 1894, and work on the creek is progressing satisfactory.

Canal Banks, Etc.

Between locks 59 and 60 there are bars which should be removed; 1,625 lineal fee of docking has been removed on Clyde, Lyons and Palmyra levels; 1,400 lineal feet of docking has been renewed in Brighton and Rochester levels. A break occurred on the Three-mile level through towpath in Brighton on the 28th

of August, about 900 feet east of Miller's lock (63); it was repaired in two and one-half days and navigation resumed in four. The Genesee river feeder bank from Lehigh Valley railroad, crossing same to Rapids dam, should be raised about two and one-half feet and strengthened with riprap. In times of high water in the river considerable anxiety is caused, and some of the State hands have to be there. The last high water gave considerable trouble to keep the water from going over the bank into the feeder.

Between the 21st and 25th of May navigation was suspended on Tonawanda creek, between Pendleton and the village of Tonawanda, caused by heavy rain and high water.

The towpath between the change bridge at Pendleton and Sulphur Spring is not in good condition and ought to be repaired. Good water has been generally maintained with few exceptions during navigation.

The corps on this division have been engaged on several surveys and maps, bridges, final estimates, deepening of Erie basin, Erie canal and Black Rock harbor, etc.

This division has been under the charge of John Bisgood and A. T. Jones, division and resident engineers, respectively.

Respectfully submitted,

JOHN BISGOOD,

Division Engineer.

Statement giving names, rank, number of days and compensation of engineers upon the repairs of the western division of the New York State canals, with incidental expenses, during the fiscal year ending September 30, 1894, *from October* 1, 1893, *to September* 30, 1894.

ORDINARY REPAIRS — ERIE CANAL.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
John Bisgood	Division engineer	1 year	$2,000 per year	$2,400 00
John Bisgood	Division engineer	Expenses		282 66
A. T. Jones	Resident engineer	202¼ days	$2,000 per year	1,.06 77
A. T. Jones	Resident engineer	Expenses		98 44
H. C. Landon	Asst. engineer in charge	12¾ days	$6 00 per day	76 50
H. C. Landon	Asst. engineer in charge	Expenses		10 00
H. C. Landon	Assistant engineer	40 days	$5 00 per day	200 00
M. W. Wilbur	Leveler	262 days	4 50 per day	1,179 00
M. W. Wilbur	Leveler	Expenses		97 15
J. B. Barrett	Rodman	214½ days	$3 50 per day	750 75
J. B. Barrett	Rodman	Expenses		21 26
C. M. Pepson	Rodman	31 days	$3 50 per day	108 50
C. M. Pepson	Rodman	Expenses		2 95
Henry Geck	Chainman	265 days	$2 50 per day	662 50
Henry Geck	Chainman	Expenses		12 56
A. C. Watson	Chainman	75 days	$2 50 per day	187 50
A. C. Watson	Chainman	Expenses		6 30
L. B. Fitch	Chainman	182 days	$2 50 per day	330 00
L. B. Fitch	Chainman	Expenses		12 97
D. D. Waldo	Chainman	78 days	$2 50 per day	195 00
D. D. Waldo	Chainman	Expenses		172 64
B. R. Salyerds	Chainman	42 days	$2 50 per day	105 00
B. R. Salyerds	Chainman	Expenses		5 84
F. F. Wilbur	Chainman	10 days	$2 50 per day	25 00
F. F. Wilbur	Chainman	Expenses		9 51
D. C. Salyerds	Chainman	10 days	$2 50 per day	25 00
D. C. Salyerds	Chainman	Expenses		9 51
J. W. Clark	Inspection Ford st. bridge			57 37
				$8,150 68

Incidental expenses.

Stationery	$155 40	
Fuel, light and office rent	402 25	
Postage and telegraph	86 13	
Telephone	100 00	
Miscellaneous account	41 25	
		785 03
		$8,935 71

EXTRAORDINARY REPAIRS — BROAD STREET CULVERT, TONAWANDA.

Chapter 244, *Laws of* 1893.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
A. T. Jones	Resident engineer	3 days	$2,000 per year	$16 31
A. T. Jones	Resident engineer	Expenses		9 90
H. C. Landon	Asst. engineer in charge	43¼ days	$6 00 per day	259 50
H. C. Landon	Asst. engineer in charge	Expenses		13 50
H. C. Landon	Assistant engineer	11 days	$5 00 per day	55 00
H. C. Landon	Assistant engineer	Expenses		11 48
M. W. Wilbur	Leveler	1 day	$4 50 per day	4 50
M. W. Wilbur	Leveler	Expenses		4 20
Dorlon Clark	Leveler	7 days	$4 50 per day	31 50
Dorlon Clark	Leveler	Expenses		12 00
J. B. Barrett	Rodman	1 day	$3 50 per day	3 50
J. B. Barrett	Rodman	Expenses		4 20
A. C. Watson	Chainman	3 days	$2 50 per day	7 50
A. C. Watson	Chainman	Expenses		9 90
				$442 99

EXTRAORDINARY REPAIRS — BUFFALO BRIDGES.

Chapter 153, *Laws of* 1893.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
A. T. Jones	Resident engineer	36 days	$2,000 per year	$199 40
A. T. Jones	Resident engineer	Expenses		53 78
M. W. Wilbur	Leveler	20 days	$4 50 per day	90 00
M. W. Wilbur	Leveler	Expenses		15 44
Henry Geck	Chainman	27 days	$2 50 per day	67 50
				$426 12

EXTRAORDINARY REPAIRS — FORD STREET BRIDGE, ROCHESTER.

Chapter 14, *Laws of* 1893.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
A. T. Jones	Resident engineer	15½ days	$2,000 per year	$86 11
M. W. Wilbur	Leveler	1 day	4 50 per day	4 50
Henry Geck	Chainman	20 days	2 50 per day	50 00
				$140 61
Incidental expenses. American Engineering and Inspection Association				35 96
				$176 57

EXTRAORDINARY REPAIRS — DREDGING OHIO BASIN, BUFFALO.

Chapter 145, *Laws of* 1894.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
A. T. Jones	Resident engineer	34 days	$2,000 per year	$184 96
A. T. Jones	Resident engineer	Expenses		91 98
J. B. Barrett	Rodman	13 days	$3 50 per day	45 50
L. B. Fitch	Chainman	4 days	2 50 per day	10 00
L. B. Fitch	Chainman	Expenses		15 17
Frank Mauerman	Chainman	39 days	$2 50 per day	97 50
Walter Dubey	Chainman	39 days	2 50 per day	97 50
William Schneider	Chainman	37 days	2 50 per day	92 50
James Thomson	Chainman	38 days	2 50 per day	95 00
				$730 11

EXTRAORDINARY REPAIRS — DREDGING ERIE BASIN, BUFFALO.

Chapter 588, *Laws of* 1894.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
James Thomson	Chainman	38 days	$2 50 per day	$95 00
Wm. Schneider	Chainman	38 days	2 50 per day	95 00
Frank Mauerman	Chainman	37 days	2 50 per day	92 50
Walter Dubey	Chainman	37 days	2 50 per day	92 50
				$375 00

EXTRAORDINARY REPAIRS — CHEMUNG CANAL NUISANCES

Chapter 226, *Laws of* 1893.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
John R. Kaley	Asst. engineer in charge	13 days	$6 00 per day	$78 00
John R. Kaley	Asst. engineer in charge	Expenses		4 00
Dorion Clark	Leveler	42 days	$4 50 per day	189 00
Dorion Clark	Leveler	Expenses		41 51
Wm. B. Osborn	Chainman	44 days	$2 50 per day	110 00
Wm. B. Osborn	Chainman	Expenses		6 65
L. B. Fitch	Chainman	5 days	$2 50 per day	12 50
L. B. Fitch	Chainman	Expenses		15 20
				$498 86

EXTRAORDINARY REPAIRS — EXAMINATIONS AND MAPS.

Chapter 358, *Laws of* 1894.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
Jay Capron	Chainman	25 95-100 days	$5 00 per day	$129 75
Jay Capron	Chainman	Expenses		8 78
James Thomson	Chainman	3 days	$2 50 per day	7 50
James Thomson	Chainman	Expenses		2 69
				$148 72

EXTRAORDINARY REPAIRS — CHEMUNG CANAL NUISANCES.

Chapter 358, *Laws of* 1894, *and Chapter* 726, *Laws of* 1893.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
John R. Kaley	Asst. engineer in charge.	46 days	$6 00 per day	$276 00
John R. Kaley	Asst. engineer in charge.	Expenses		51 54
W. L. Curtis	Assistant engineer	5 days	$5 00 per day	25 00
W. L. Curtis	Assistant engineer	Expenses		44 17
L. B. Fitch	Chainman	5 days	$3 50 per day	17 50
L. B. Fitch	Chainman	Expenses		18 22
Guy Miller	Chainman	5 days	$2 50 per day	12 50
Guy Miller	Chainman	Expenses		14 34
H. J. Richardson	Chainman	5 days	$2 50 per day	12 50
C. H. Nicholds	Chainman	47 days	2 50 per day	117 50
				$589 27
Incidental expenses.				
Stationery			$36 74	
Livery			45 75	
				82 49
				$671 76

EXTRAORDINARY REPAIRS — IMPROVING CANAL AT BUFFALO.

Chapter 119, *Laws of* 1893.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
A. T. Jones	Resident engineer	4 days	$2,000 per year	$22 22
A. T. Jones	Resident engineer	Expenses		14 77
Wm. Schneider	Chainman	84 days	$2 50 per day	210 00
Walter Dubey	Chainman	83 days	2 50 per day	207 50
Frank Mauerman	Chainman	83 days	2 50 per day	207 50
James Thomson	Chainman	83 days	2 50 per day	207 50
				$869 49
Incidental expenses.				
Stationery				5 50
				$874 99

EXTRAORDINARY REPAIRS — IMPROVING HONEOYE OUTLET.

Chapter 563, *Laws of* 1893.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
A. T. Jones	Resident engineer		$2,000 per year	$130 43
A. T. Jones	Resident engineer	Expenses		42 08
W. L. Curtis	Assistant engineer	40 days	$5 00 per day	200 00
M. W. Wilbur	Leveler	6 days	4 50 per day	27 00
M. W. Wilbur	Leveler	Expenses		6 80
H. A. Van Alstyne	Leveler	40 days	$4 50 per day	180 00
J. B. Barrett	Rodman	12 days	3 50 per day	42 00
J. B. Barrett	Rodman	Expenses		1 50
Jay Capron	Chainman	19 days	$5 00 per day	95 00
Jay Capron	Chainman	Expenses		10 02
L. B. Fitch	Chainman	40 days	$3 50 per day	140 00
Chauncey Hurlburt	Chainman	35 days	2 50 per day	87 50
Chauncey Hurlburt	Chainman	Expenses		16 10
Guy Miller	Chainman	40 days	$2 50 per day	100 00
John Hackett	Chainman	40 days	2 50 per day	100 00
F. F. Wilbur	Chainman	12 days	2 50 per day	30 00
F. F. Wilbur	Chainman	Expenses		1 80
Wm. Mason	Labor	12 days	$2 50 per day	30 00
L. G. Bentley	Labor	10½ days	2 50 per day	26 25
				$1,266 73

EXTRAORDINARY REPAIRS — WALL BETWEEN ST. PAUL STREET AND PINNACLE AVENUE, ROCHESTER, N. Y.

Chapter 726, *Laws of* 1893.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
M. W. Wilbur	Leveler	25 days	$4 50 per day	$112 50
M. W. Wilbur	Leveler	Expenses		15
J. B. Barrett	Rodman	6½ days	$3 50 per day	22 75
				$135 40

EXTRAORDINARY REPAIRS — OAK ORCHARD CREEK AND FEEDER.

Chapter 136, *Laws of* 1893.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
A. T. Jones	Resident engineer	4 days	$2,000 per year	$21 74
A. T. Jones	Resident engineer	Expenses		8 96
D. D. Waldo	Chainman	156 days	$4 50 per day	702 00
D. D. Waldo	Chainman	Expenses		49 35
D. D. Waldo	Chainman	72 days	$2 50 per day	180 00
D. D. Waldo	Chainman	Expenses		146 33
John Grinnell	Chainman	78 days	$3 50 per day	273 00
John Grinnell	Chainman	12 days	2 50 per day	30 00
Wm. Comerford	Chainman	72 days	2 50 per day	180 00
B. Toner	Chainman	17 days	2 50 per day	42 50
A. Neibuhr	Chainman	12 days	2 50 per day	30 00
George Moreland	Chainman	64 days	2 50 per day	160 00
				$1,823 88

Incidental expenses.

Fuel and office expenses	$72 16	
Telegraph	13 25	
Miscellaneous account	35 64	
Livery	89 50	
		210 55
Total		$2,034 43

EXTRAORDINARY REPAIRS — DREDGING, ETC., ERIE BASIN AND BLACK ROCK HARBOR, BUFFALO, N. Y.

Chapter 119, *Laws of* 1893.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
A. T. Jones	Resident engineer	42 days	$2,000 per year	$232 06
A. T. Jones	Resident engineer	Expenses		49 65
J. B. Barrett	Rodman	65 days	$3 50 per day	227 50
J. B. Barrett	Rodman	Expenses		3 86
L. B. Fitch	Chainman	24 days	$2 50 per day	60 00
L. B. Fitch	Chainman	Expenses		8 16
A. C. Watson	Chainman	12 days	$2 50 per day	30 00
A. C. Watson	Chainman	Expenses		8 22
E. F. Bapst	Chainman	90 days	$2 50 per day	225 00
W. H. Girven	Chainman	90 days	2 50 per day	225 00
Henry Neenan	Chainman	129 days	2 50 per day	322 50
James Kane	Chainman	90 days	2 50 per day	225 00
Frank Mauerman	Chainman	45 days	2 50 per day	112 50
Walter Dubey	Chainman	39 days	2 50 per day	97 50
James Thomson	Chainman	45 days	2 50 per day	112 50
Wm. Schneider	Chainman	12 days	2 50 per day	30 00
				$1,969 45

EXTRAORDINARY REPAIRS — GENESEE RIVER STORAGE SURVEY.

Chapter 726, *Laws of* 1893.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
George W. Rafter	Asst. engineer in charge	61 days	$6 00 per day	$366 00
George W. Rafter	Asst. engineer in charge	Expenses		348 39
Wallace Greenalch	Rodman	43 days	$3 50 per day	150 50
Wallace Greenalch	Rodman	Expenses		23 16
M. S. Smith	Draughtsman	53 days	$2 50 per day	182 50
M. S. Smith	Draughtsman	Expenses		1 57
D. D. Waldo	Chainman	7 days	$2 50 per day	17 50
D. D. Waldo	Chainman	Expenses		16 14
M. F. Wemple	Chainman	56 days	$2 50 per day	140 00
M. F. Wemple	Chainman	Expenses		14 00
S. W. Linendoll	Chainman	24 days	$2 50 per day	60 00
S. W. Linendoll	Chainman	Expenses		6 90
				$1,274 66

Incidental expenses.

Stationery	$15 35	
Fuel, light and office rent	211 69	
Postage and telegraph	6 71	
Miscellaneous account	564 57	
Labor	2,157 58	
E. B. Osborn, hardware	233 10	
J. H. Burtis, livery	209 50	
Sullivan Machinery Co., Diamond drill	506 66	
		3,905 11
		$5,179 77

EXTRAORDINARY REPAIRS — FALL CREEK WALL, HAVANA, N. Y.

Chapter 345, *Laws of* 1894.

NAME.	Rank.	Number of days, etc.	Rate of compensation.	Total amount.
H. A. Van Alstyne	Leveler	4 days	$4 50 per day	$18 00
H. A. Van Alstyne	Leveler	Expenses		11 00
John Hackett	Chainman	3 days	$2 50 per day	7 50
John Hackett	Chainman	Expenses		10 33
				$46 83

SUMMARY OF ENGINEERING EXPENSES UPON THE WESTERN DIVISION NEW YORK STATE CANALS FOR THE FISCAL YEAR ENDING SEPTEMBER 30, 1894.

Extraordinary Repairs.

	Amount.
Broad street culvert, Tonawanda, N. Y., chapter 244, Laws of 1893	$442 99
Fall creek wall, Havana, N. Y., chapter 345, Laws of 1894	46 83
Buffalo bridges, Buffalo, N. Y., chapter 153, Laws of 1893	426 12
Ford street bridge, Rochester, N. Y., chapter 14, Laws of 1893	176 57
Deepening Erie basin, Buffalo, N. Y., chapter 588, Laws of 1894	375 00
Examination and maps, chapter 358, Laws of 1894,	148 72
Abating nuisances, Chemung canal, chapter 358, Laws of 1894, and chapter 726, Laws of 1893	671 76
Wall between Pinnacle avenue and St. Paul street, chapter 726, Laws of 1893	135 40
Dredging, etc., Ohio basin, Buffalo, N. Y., chapter 145, Laws of 1894	730 11
Abating nuisances, Chemung canal, chapter 726, Laws of 1893	493 86
Deepening, etc., Honeoye outlet, chapter 563, Laws of 1893	1,266 73
Oak Orchard creek and feeder, chapter 136, Laws of 1893	2,034 43

Improving canal at Buffalo, N. Y., chapter 119, Laws of 1893	$874 99
Deepening, etc. Erie basin and Black Rock harbor, chapter 119, Laws of 1893	1,969 45
Genesee River Storage Survey, chapter 726, Laws of 1893	5,179 77
Ordinary repairs	8,935 71
Total engineering expenses for western division,	$23,908 44

ERIE CANAL.—LIST OF BRIDGES ON WESTERN DIVISION.

Miles.	Number.	Cast Iron. Whipple arch.	Cast Iron. Whipple trapezoidal.	Cast Iron. Bollman.	Cast Iron. Swartz.	Cast Iron. Pipe.	Wrought Iron. Cooper's arch.	Wrought Iron. Bow string.	Wrought Iron. Lattice.	Wrought Iron. Lift.	Wrought Iron. Swing.	Wrought Iron. Roof.	Whipple (wood and iron).	Wood. Whipple.	Wood. Draw.	Remarks.
....	1												1			Wayne county line, east end of division.
1.03	2	1														Pit lock.
4.01	3	1														Waldruff's.
6.45	4									1						Glasgow street, Clyde.
6.54	5	1														Sodus street, Clyde.
7.76	6													1		Sigman's.
8.68	7													1		Barker's.
9.85	8													1		Long's.
10.71	9								1							Lock Berlin.
11.27	10	1														Horton's.
11.74	11												1			Goetzman's.
12.45	12													1		Klaus'.
12.78	13													1		Richmond.
13.06	14								1							Cole's.
13.93	15	1														Geneva street, Lyons.
14.00	16	1														Church street, Lyons.
14.10	17	1														Water street, Lyons.
14.29	18	1														Leach's.
15.45	19													1		Prine's.
15.85	20								1							Park's.
16.90	21								1							Mosher's.
17.99	22							1								Towpath change.
19.28	23	1														Lockville.
19.90	24	1														Charles street, Newark.
20.04	25	1														Main street, Newark.
21.18	26	1														Allerton's.
21.78	27	1														Peek's.
22.47	28													1		Sweezey's.
22.98	29													1		Palmer's.
23.44	30	1														Port Gibson.
26.00	31								1							Galloway's.
27.84	31½				1											Kent street.
28.26	32	1														Railroad avenue, Palmyra.

28.59	33	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Market street, Palmyra.
28.79	34	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Church street, Palmyra.
29.48	35	......	......	......	......	1	......	......	......	......	......	......	......	......	......	Towpath change, Palmyra.
30.07	36	......	......	......	......	......	......	......	......	......	......	......	......	1	......	Crandall's.
30.41	37	......	......	......	......	......	......	......	......	......	......	......	......	1	......	Clark's.
31.26	38	1	......	......	......	......	......	......	......	......	......	......	......	......	......	White's.
31.95	39	......	......	......	......	......	......	......	1	......	......	......	......	......	......	Towpath changed and highway, Macedon.
32.53	40	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Macedon.
33.54	41	......	......	......	......	......	......	......	......	......	......	......	......	1	......	Frear's.
35.69	42	......	......	......	......	......	......	......	......	......	......	......	......	1	......	Wayneport.
38.01	43	......	......	......	......	......	......	......	......	......	......	......	......	1	......	Knapp's.
39.69	44	......	......	......	......	......	......	......	......	......	......	......	1	......	......	Baker's.
40.14	45	......	......	......	......	......	......	......	1	......	......	......	......	......	......	Parker's, Fairport.
40.30	46	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Main street, Fairport.
41.28	47	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Fullam's basin.
42.81	48	......	......	......	......	......	......	......	......	......	......	......	1	......	......	Wapping.
43.15	49	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Wiltsie's.
44.26	50	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Bushnell's basin.
45.86	51	......	......	......	......	......	......	......	......	......	......	......	......	1	......	Cartersville.
46.50	52	......	......	......	......	......	......	......	......	......	......	......	1	......	......	Guernsey's.
47.00	53	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Pittsford.
47.30	54	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Main street, Pittsford.
47.75	55	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Sutherland's.
49.96	56	......	......	......	......	......	......	......	......	......	......	......	1	......	......	Cook's.
50.03	57	......	......	......	......	......	......	......	......	......	......	......	......	1	......	Weed's.
50.52	58	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Billinghurst's.
51.39	59	......	......	......	......	......	......	......	......	......	......	......	1	......	......	Donnelly's.
52.00	60	......	......	......	......	......	......	......	......	......	......	......	1	......	......	Drake's.
52.66	61	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Brighton.
53.65	62	......	......	......	......	......	......	......	1	......	......	......	......	......	......	Culver road, city line Rochester.
54.23	63	......	......	......	......	......	......	......	1	......	......	......	......	......	......	Monroe avenue, Rochester.
54.64	64	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Goodman street, Rochester.
54.79	65	......	......	......	......	......	1	......	......	......	......	......	......	......	......	Nelson street, Rochester.
55.01	66	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Averill street, Rochester.
55.11	67	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Alexander street, Rochester.
55.35	67½	......	......	......	......	......	......	......	1	......	......	......	......	......	......	Pinnacle avenue, Rochester.
55.48	68	......	......	......	......	......	......	......	1	......	......	......	......	......	......	St. Paul street, Rochester.
55.51	69	......	......	......	......	1	......	......	......	......	......	......	......	......	......	Griffith street, Rochester.
55.67	70	......	......	......	......	......	......	1	......	......	......	......	......	......	......	Towpath Change, weighlock, Rochester.
56.03	73	......	......	......	......	......	......	......	......	......	1	......	......	......	......	Exchange street, Rochester.
56.12	74	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Fitzhugh street, Rochester.
56.27	76	......	......	1	......	......	......	......	......	......	......	......	......	......	......	Washington street, Rochester.
56.38	76½	......	......	......	......	......	......	......	......	1	......	......	......	......	......	Caledonia avenue, Rochester.
56.43	77	......	......	......	......	......	......	......	......	1	......	......	......	......	......	West avenue, Rochester.
56.49	78	......	......	......	......	......	......	......	1	......	......	......	......	......	......	Ford street, Rochester.
56.61	79	......	......	......	......	1	......	......	......	......	......	......	......	......	......	Towpath over Genesee Valley canal, Rochester.
56.98	83	1	......	......	......	......	......	......	......	......	......	......	......	......	......	Jay street, Rochester.
58.23	85	......	......	1	......	......	......	......	......	......	......	......	......	......	......	Emerson street, Rochester.
58.75	86	......	......	......	......	......	......	......	......	1	......	......	......	......	......	Rowe street.
58.95	87	......	......	......	......	......	......	1	......	......	......	......	......	......	......	Towpath change.

ERIE CANAL — LIST OF BRIDGES ON WESTERN DIVISION — (*Continued*).

Miles.	Number.	Cast Iron. Whipple arch.	Cast Iron. Whipple trapezoidal.	Cast Iron. Bollman.	Cast Iron. Swarts.	Cast Iron. Pipe.	Wrought Iron. Cooper's arch.	Wrought Iron. Bow string.	Wrought Iron. Lattice.	Wrought Iron. Lift.	Wrought Iron. Swing.	Wrought Iron. Roof.	Whipple (wood and iron).	Wood. Whipple.	Wood. Draw.	Remarks.
59.57	88												1			Scott's.
60.11	89													1		Four-mile grocery.
62.08	90												1			Speirs'.
62.85	91		1													Six-mile grocery.
62.97	92												1			Douglas'.
63.65	93												1			Finley's.
63.93	94												1			South Greece.
65.04	95	1														Cromwell's.
66.10	96	1														Hiscock's.
67.01	97												1			Norman's.
67.56	98	1														Union street, Spencerport.
67.77	99	1														Amity street, Spencerport.
68.78	100	1														Webster's east.
69.13	101													1		Webster's west.
70.15	102		1													Cressy's, Adams basin.
70.49	103	1														Adams basin.
71.56	104	1														Doty's.
72.62	105	1														Brockway's.
73.93	106	1														Cooley's basin.
75.03	107	1														Mechanics street, Brockport.
75.20	108									1						Main street, Brockport.
75.50	109	1														Smith street, Brockport.
76.70	110	1														Danforth's.
78.09	111								1							Miner's.
78.37	112	1														County line between Monroe and Orleans.
79.23	113							1								Orr's.
......	44	1														Frisbie's old canal, Holley.
79.74	115	1														Holley.
80.41	116	1														McCarty's.
81.25	117				1											Tuttle's.
81.74	118												1			McGuire's.
82.84	119	1														Hulberton.
84.15	120	1														Brockville.
84.92	121	1														Hindsburgh.
85.42	122							1								Transit road.

86.44	123												1			Jaquith's.
87.14	124													1		Bidwell's.
87.98	125				1											Bradley's.
88.68	126	1														Hall's.
89.24	127			1												Ingersoll street, Albion.
89.40	128										1					Batavia street, Albion.
90.50	129													1		Lattin's.
91.12	130								1							Gaines' basin.
92.66	131	1														Eagle harbor.
93.18	132													1		Starkweather's.
93.42	133	1														Allen's.
93.91	134													1		Long's.
95.72	135	1														Knowlesville.
98.09	136													1		Beal's.
98.88	137	1														Hastings'.
99.52	138	1														Holloway's, Medina.
99.90	139	1														Church street, Medina.
100.18	140	1														Shelby street, Medina.
100.86	140½								1							Prospect street, Medina.
101.86	141													1		Jackson's.
102.58	142								1							Shelby basin.
103.27	143													1		Town line.
105.04	144													1		Vernon street, Middleport.
105.11	145	1														Main street, Middleport.
105.83	146								1							Williams'.
106.63	147													1		Watson's.
108.19	148								1							Hurd's.
108.78	149													1		Reynales' basin.
109.49	150	1														Mabee's.
110.89	151								1							Gasport.
111.42	152	1														Orangeport.
113.38	153	1														Millard's.
114.25	154													1		Wakeman's.
115.16	155	1														Young's, Lockport (lower town).
115.90	156	1														Comstock's, Lockport (lower town).
116.15	157	1														Adams street, Lockport (lower town).
116.26	158	1														Chapel street, Lockport (lower town).
116.35	159			1												Exchange street, Lockport (lower town).
116.57	160												1			Cady's, Lockport (lower town).
116.89	161		1													Pine street (two spans) Lockport (upper town).
117.00	162											1				Cottage street, Lockport (upper town).
117.03	163											1				Main street, Lockport (upper town).
117.18	164	1														Transit road, Lockport (upper town).
117.55	164½								1							Prospect street.
118.36	165	1														Hitchins'.
120.01	166	1														Heacox's, one iron and two wood spans.
120.92	167		1													Hawley's, one iron and two wood spans.
122.11	168													1		Sulphur Spring guard lock; three spans of wood.
123.62	169		1			1										Pendleton highway and towpath change.
......	170					1										Old canal, Pendleton.

ERIE CANAL — LIST OF BRIDGES ON WESTERN DIVISION — (*Continued*).

		CAST IRON.					WROUGHT IRON.							WOOD.		
Miles.	Number.	Whipple arch.	Whipple trapezoidal.	Ballman.	Swartz.	Pipe.	Cooper's arch.	Bow string.	Lattice.	Lift.	Swing.	Roof.	Whipple (wood and iron).	Whipple	Draw.	Remarks.
123.66	171	...	...	...	...	...	...	...	...	...	...	...	1	...	...	Towpath over Tonawanda creek, Pendleton; three spans.
125.42	172	...	...	...	...	...	...	...	...	...	...	...	...	1	...	Ransom creek, towpath.
126.52	173	...	...	...	...	...	...	...	...	...	...	...	1	...	...	New Home, two spans.
128.07	174	...	...	...	...	...	...	...	...	...	...	...	1	...	...	Pickard's, two spans wood and iron and one wood.
131.29	175	...	...	...	...	...	...	1	...	...	...	...	...	...	...	Bush's, near Martinsville.
135.19	175½	...	...	...	...	...	...	...	1	...	...	...	...	...	...	Connecting Delaware avenue and Main street, Tonawanda; three spans.
135.28	176	1	...	...	...	...	...	...	...	...	...	...	...	...	...	Ellicott creek, towpath, Tonawanda.
135.34	177	...	...	...	...	...	...	...	1	...	...	...	...	...	...	Main street, Tonawanda.
135.40	178	1	...	...	...	...	...	...	...	...	...	...	...	...	...	River lock slip, Tonawanda.
135.46	179	1	...	...	...	...	...	...	...	...	...	...	...	...	...	Seymour street, Tonawanda.
135.72	180	...	...	1	...	...	...	...	...	...	...	...	...	...	...	Bouck street, Tonawanda.
136.38	181	...	...	...	...	1	...	...	...	...	...	...	...	...	...	Towpath change, Tonawanda.
136.38½	182	1	...	...	...	...	...	...	...	...	...	...	...	...	...	Grand Island ferry.
138.03	183	...	...	...	...	...	...	...	...	...	...	...	1	...	...	Three Mile.
139.06	184	...	...	...	...	...	...	...	...	...	...	...	1	...	...	Chevey's.
139.93	185	...	...	...	...	...	...	...	...	...	...	...	...	1	...	Lineberg's.
140.96	186	1	...	...	...	...	...	...	...	...	...	...	...	...	...	Scott's Grand Island ferry.
142.74	187	...	...	...	...	1	...	...	...	...	...	...	...	...	...	Towpath change, Black Rock.
142.81	188	...	...	...	...	...	...	1	...	...	...	...	...	...	...	Towpath lift, north side of canal (Swartz), Black Rock.
142.96	189	1	...	...	...	...	...	...	...	...	...	...	...	...	...	Bird avenue, Black Rock.
143.15	189½	...	...	...	...	...	...	...	1	...	...	...	...	...	...	Austin street, Black Rock.
143.29	190	...	...	...	...	...	1	...	...	...	...	...	...	...	...	Hamilton street, Black Rock.
143.42	191	1	...	...	...	...	...	...	...	...	...	...	...	...	...	Amherst street, Black Rock.
143.53	192	...	...	...	...	...	...	...	...	...	...	...	...	1	...	Mill street, Black Rock.
143.75	193	...	...	...	...	...	...	...	...	...	...	...	...	...	1	Scajaquada creek, towpath.
144.83	194	...	...	...	...	...	...	...	1	...	...	...	...	...	...	Ferry street, Upper Black Rock.
	195	...	...	...	...	...	...	...	...	...	1	...	...	...	...	Continuation of Ferry street across harbor to ferry for Canada.
146.04	196	...	...	...	...	...	...	...	1	...	...	...	...	...	...	York street, T. P., change and highway, Buffalo.
146.48	196½	...	...	...	...	...	...	...	1	...	...	...	...	...	...	Hudson street, Buffalo.
146.9[illegible]	197	1	...	...	...	...	...	...	...	...	...	...	...	...	...	Georgia street, Buffalo.
147.06	198	1	...	...	...	...	...	...	...	...	...	...	...	...	...	Towpath, slip No. 3, Buffalo.

	199													1	Wilkinson slip, B. S., Buffalo.
147.23	200								1						Genesee street, Buffalo.
147.26	201	1													Towpath, slip No. 2, Buffalo.
147.30	202							1							Towpath, slip No. 1, Buffalo.
147.50	203	1													Erie street, Buffalo.
147.70	204								1						Commercial street, Buffalo.
	207								1						Lloyd street, Buffalo.
		83	5	5	3	7	2	8	29	5	3	2	23	33	2	

LIST OF BRIDGES ON WESTERN DIVISION—(*Continued*).

COMMERCIAL SLIP, BUFFALO.

Number.	Wrought iron. Lattice.	Remarks.
205	1	Canal street.
206	1	Prime street.
	2	

OHIO SLIP, BUFFALO.

Number.	Cast iron. Whipple arch.	Wrought iron. Lattice.	Wrought iron. Swing.	Wrought iron. Bow-string.	Remarks.
217	....	1	......	......	Perry street.
218	1	......	......	......	Fulton street.
219	....	......	......	1	Elk street.
220	....	......	1	......	Ohio street basin.
	1	1	1	1	

HAMBURGH CANAL, BUFFALO.

Number.	Cast iron. Whipple arch.	Wrought iron. Lattice.	Remarks.
208	1	....	Main street.
209	......	1	Washington street.
214	1	....	Michigan.
215	1	....	Chicago.
216	......	1	Louisiana street.
	3	2	

CLARK AND SKINNER CANAL, BUFFALO.

Number.	Cast-iron. Whipple arch.	Cast-iron. Bollman.	Wrought-iron. Lattice.	Remarks.
210	......	......	1	Scott street.
211	1	......	....	Perry street.
212	......	1	....	Elk street.
213	......	1	....	Ohio street.
	1	2	1	

SUMMARY.

LOCATION.	CAST IRON.					WROUGHT IRON.						WOOD AND IRON.	WOOD.		Total.
	Whipple arch.	Whipple trapezoidal.	Bollman.	Swartz.	Pipe.	Cooper's arch.	Bow string.	Lattice.	Lift.	Swing.	Roof.	Whipple.	Whipple.	Draw.	
Erie canal	32	5	5	3	7	2	8	29	5	3	2	22	82	2	207
Commercial slip	......	......	......	......	......	......	......	2	......	......	......	......	......	......	2
Ohio slip	1	......	......	......	......	......	1	1	......	1	......	......	......	......	4
Hamburgh canal	3	......	......	......	......	......	......	2	......	......	......	......	......	......	5
Clark and Skinner canal	1	......	2	......	......	......	......	1	......	......	......	......	......	......	4
Oak Orchard creek feeder on Batavia road, Orleans Co	......	......	......	......	1	......	......	......	......	......	......	......	......	......	1
	37	5	7	3	8	2	9	35	5	4	2	22	82	2	223

TABLE OF CONTRACTS PENDING ON THE WESTERN DIVISION ON THE 30TH DAY OF SEPTEMBER, 1894.

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Appropriation.	Legislative Act. Chap.	Legislative Act. Year.	Engineer's preliminary estimate.	Engineer's estimate at contract prices.	Payments to date.
		Oak Orchard Creek and Feeder.						
MacGregor & Hughes	Sept. 25, 1893	Improving Oak Orchard and Oak Orchard feeder	$35,000 00	186	1893	$30,900	$29,000 00	$18,360
		Chemung Canal Nuisances.						
A. F. Chapman	Aug. 3, 1894	Ditching and rebuilding culverts for abating the nuisance on Chemung canal on the lands of General A. Divens and others between Lock 48 and Grand Central avenue, Elmira, N. Y	....	726 358	1893 1894	....	$4,208 60	$1,178
A. F. Chapman	July 23, 1894	Abatement of nuisances on Chemung canal between Horseheads and Pine Valley and at lock 26, Millport, on the Chemung canal. Feeder at East Corning on the lands of Haight, Goff & Gillett	....	726 358	1893 1894	....	4,428 90	3,604
A. F. Chapman	July 23, 1894	Abatement of nuisances on Chemung canal at the culvert between locks Nos. 1 and 2, at lock No. 3 and at Falls creek, Havana	$11,500 82	726 358	1893 1894	....	898 40	374
		Falls Creek Wall, Havana.						
John Coughlin	July 24, 1894	Vertical wall laid in cement to protect east bank of Falls creek in Havana, N. Y	$5,000 00	345	1894	$3,700	$1,808 00	$952
		Erie Basin, Buffalo.						
Hingston & Woods	July 23, 1894	Improving and dredging Erie basin in city of Buffalo, N. Y	$3,925 00	588	1894	$3,527	$1,998	None.

TABLE OF CONTRACTS ON WESTERN DIVISION COMPLETED DURING THE YEAR ENDING SEPTEMBER 30, 1894.

Erie Canal.

NAME OF CONTRACTOR.	Date of contract.	Character of work.	LEGISLATIVE ACT. Chap.	LEGISLATIVE ACT. Year.	Appropriation.	Engineer's estimate at contract prices.	Final estimate.	Remarks.
Kellogg Iron Works.	Jan. 26, 1894	Wrought-iron bridge superstructure over Erie canal at Ford street, Rochester	14	1893	$6,000	$2,845 00	$2,845 00	See note.
Hingston & Woods..	Jan. 19, 1894	Removing obstructions from the prism of Erie canal in the city of Buffalo, N. Y.	119	1893	10,000	7,872 00	6,981 07	
Hilton Bridge Con. Co	Sept. 28, 1894	Four bridges over New York State canals in the city of Buffalo, N. Y	153	1893	20,500	15,725 00	15,725 00	
George H. Nagle....	Mar. 13, 1894	Dry rubble wall on north side of Erie canal between South St. Paul street and Pinnacle avenue, bridges in the city of Rochester, N. Y.	726	1893	2,000	1,415 95	1,289 43	
		Erie Basin and Black Rock Harbor, Buffalo.						
Hingston & Woods..	Aug. 17, 1893	Deepening and improving the Erie basin and Black Rock harbor, Buffalo	1:9	1893	30,000	20,380 00	23,794 91	
		Oak Orchard Creek and Feeder.						
MacGregor & Hughes	Sept. 25, 1893	Bulkhead for Oak Orchard feeder in Medina	186	1893	35,000	766 30	674 77	Work done in part under appropriation.
		State Ditch, Tonawanda.						
Ed. H. Rogers, Jr...	Aug. 14, 1893	Arch culvert over State ditch on Broad street, Tonawanda, N. Y	244	1893	5,000	4,565 00	4,410 26	
		Honeoye Outlet.						
Michael Bennett.....	July 26, 1894	Deepening and improving the channel of Honeoye outlet in the town of Richmond, Ontario county..	563	1893	5,000	3,251 00	3,288 28	
		Chemung Canal.						
James Robinson.....	Sept. 21, 1893	Abating nuisances on the Chemung canal in Big Flats, Chemung county	7:6	1893	15,000	2,887 60	2,582 67	

NOTE.—This contract was let to W. H. Shepard & Sons, April 5, 1894, for $3,935, but on their failure to fulfill contract was relet on January 11, 1894 to Kellogg Iron Works for $2,845.

APPENDIX E.

FINAL REPORT

ON THE

GENESEE RIVER STORAGE PROJECT

BY

GEO. W. RAFTER, ENGINEER IN CHARGE,

MADE TO CAMPBELL W. ADAMS, STATE ENGINEER AND SURVEYOR,
APRIL 1, 1894.

APPENDIX E.

ALBANY, *April* 1, 1894.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor:*

Sir.— I have the honor to submit herewith my final report on the Genesee river storage project.

In a preliminary report made to your predecessor, the Hon. Martin Schenck, under date of December 15, 1893, it is stated that in view of the suggestion that the proposed storage dam might be economically constructed of concrete from available local material, an extensive series of experiments on this material had been carried out. The experimental blocks have now been tested and the results compiled, and we may properly begin by an exhibit of the information acquired and the conclusions arrived at.

The objects to be obtained by these concrete tests were as follows:

(1.) To determine whether the Genesee shales, which exist in vast quantity in the sides of the gorge and immediately at all the dam sites, could be used as the aggregate of concrete, either for the entire work or for a portion of it.

(2.) To also determine the value of stone from deposits some distance away from the work, but still near enough to be fairly available, for the same purpose.

(3.) To determine the constructive value of such American cements as from their nearness to Mount Morris may be considered especially available for this work.

(4.) To determine the value of the local sand, in combination with the available cements and concrete aggregates.

The stones used in the tests are (1) the Genesee shale, as taken from the sides of the gorge immediately at Dam Site No. 2; (2) stone from Ridge quarry, which is located about three miles from Dam Site No. 2, the available information with regard to which

has been given in the preliminary report; (3) from Portage, and (4) from Nunda. The controlling circumstances at these two latter quarries are also indicated in the preliminary report.

The cements used in the tests were (1) Cumming's Buffalo; (2) Newman's Akron; (3) Bangs & Gaynor's Fayetteville; (4) Norton's Rosendale; (5) Millem's Wayland Portland and (6) Saylor's Portland.

The sand used was from extensive banks in the immediate vicinity of Dam Site No. 1.

These several stones have all been broken to pass through a two-inch ring, washed clean and combined with various proportions of sand and cement. One hundred and seventy-four test cubes of one foot each were molded, and a record kept of all the attendant conditions from the time of the moulding until the breaking of the blocks in the month of February. Table No. 2 presents the complete data of the tests.

As preliminary to the tests the voids of the several varieties of stone to be used as aggregates were determined in the following manner: A water-tight cubic foot measure was first filled with the material of which the voids were to be determined. After striking off and weighing, the voids were filled with water, and the whole again weighed. The difference of the two weights represents the weight of the water added to fill the voids of a cubic foot. The ratio of the weight of a cubic foot of water to that of the amount required to fill the voids gives the percentage of the voids.

Proceeding in this way several determinations were made in each case and the means taken. The following are the results reached:

(1) For the Genesee shale, when thrown into the measure with a shovel and slightly shaken, so that the solidity of the material fairly represented that of ordinary measuring in quantity, the mean of five determinations gave the voids as 38.3 per cent. The range of the five was from 36.1 as a minimum to 41.3 per cent as a maximum.

(2) With the shale packed in the measure with a tamping iron, used about as forcibly as for the ordinary ramming of concrete,

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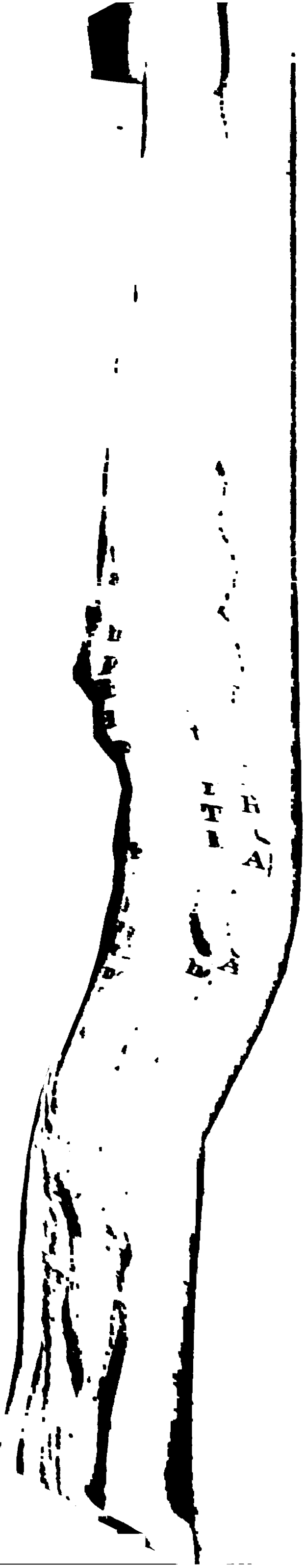

the mean of four trials was 31.6 per cent, the range of the four being from 28.8 to 33.6 per cent.

(3) The mean of both of the preceding series (mean of nine determinations) was 34.9 per cent.

(4) For broken stone from the Ridge quarry, slightly shaken, the mean of five trials was 46.2 per cent. The range was from 44.5 to 48.5.

(5) Ridge quarry stone packed gave a mean percentage of voids from five trials of 38.6 per cent. The range was from 36.9 to 39.3 per cent.

(6) The mean of ten trials included in (4) and (5) was 42.4 per cent.

(7) For broken stone from Portage, slightly shaken, the mean of five trials was 43.3 per cent. The range was from 41.7 to 45.3 per cent.

(8) Portage stone packed gave a mean from five trials of 37.4 per cent. The range was from 35.7 to 39.3 per cent.

The mean of the ten included in (7) and (8) was 40.4 per cent.

(10)For broken stone from Nunda, slightly shaken, the mean of five trials was 43.2 per cent. The range was from 41.7 to 44.9.

(11) Nunda stone packed gave a mean from five trials of 38.5 per cent. The range was from 37.3 to 39.7 per cent.

(12) The mean of the ten tests included in (10) and (11) was 40.8 per cent.

The voids in the sand used in the tests were found as the mean of 12 determinations, to be 31.7 per cent. The range was from 35.6 per cent for dry sand from top of pile slightly shaken, to 28.0 per cent for damp sand from the center of large pile packed.

As this sand would ordinarily be measured into work the voids may be expected to average about 32 to 33 per cent.

With the exception of Norton's Rosendale, tensile tests of the several cements used in the concrete blocks were made at the State testing office, and the results are presented in Table No. 1.

Norton's Rosendale was not tested for tensile strength, etc., because the samples forwarded to the State testing office were accidentally destroyed, and the press of work at that office pre-

vented the obtaining and testing of further samples. The concrete tests indicate, however, that this cement, when used in concrete, will not vary essentially from the other natural cements of which the detailed tensile and other tests are given in Table No. 1.

In the tensile tests of Table No. 1, a series have been made with the Mt. Morris sand, as well as with the standard quartz used ordinarily for test purposes. Some of the results brought out are of considerable interest, as, for instance, with Saylor's Portland cement, the standard quartz, 1 to 1, gives 329 pounds tensile in seven days and 450 pounds in twenty-eight days, while with Mt. Morris sand, 1 to 1, Saylor's Portland gives only 257 pounds in seven days, and 317 pounds in twenty-eight days. In 2 to 1 proportion the quartz is still superior to the Mt. Morris sand. In 3 to 1 they are about equal; in 4 to 1 the Mt. Morris sand is somewhat superior to the quartz, while in 5 to 1 proportion the sand is still better than the quartz.

If we analyze the tests of Wayland Portland in the same way we observe that for the 1 to 1 proportion the superiority of the quartz over the Mt. Morris sand is much more marked than in the previous case. Thus the quartz gives 436 and 516 pounds in seven and twenty-eight days, respectively, while the sand, 1 to 1, is only 363 and 442 pounds for seven and twenty-eight days, respectively.

At 3 to 1, 4 to 1 and 5 to 1, the quartz and sand are practically equal, although there is a slight superiority of the sand in the 5 to 1 mixture.

An explanation of these interesting results is offered when we examine the column of fineness in Table No. 1, from which it is seen that a sieve of 2,500 meshes to the square inch passes 100 per cent of Saylor's Portland and one of 10,000 meshes passes 97 1-2 per cent of this cement. The Wayland Portland is considerably coarser, 98 3-4 per cent passing the screen of 2,500 meshes, while only 87 1-2 per cent passes the screen of 10,000 meshes.

As between the standard quartz and the Mt. Morris sand the quartz is considerably coarser, the result being that when small

proportions of cement are used as in 4 to 1 and 5 to 1 mixtures the finer Saylor's Portland is able to more thoroughly coat the particles, large and small, of the Mt. Morris sand, than of the coarse quartz. In the case of the Wayland Portland, with 12 1-2 per cent larger than the 10,000 to the inch mesh, we may apparently assume that the 12 1-2 per cent of the cement which fails to pass the sieve of 10,000 meshes is just what is required to fill the voids in the coarse quartz, and hence there results greater homogeneity of the whole mass, with its corresponding increase in cohesive strength. On the other hand, in the case of the Mt. Morris sand, which contains a certain per cent of particles of approximately the same size as these coarse cement particles, there are no void spaces for the cement particles to specially fit into, but they merely act to increase the bulk of the sand; hence there results less homogeneity of the mass, with a corresponding decrease in cohesive strength. It is clear, then, that finer grinding of the Wayland cement would considerably increase its strength when used with the Mt. Morris sand, while with the standard quartz finer grinding would not be likely to lead to any increase in strength and might even lead to a small decrease.

It may be mentioned, however, that even with the disadvantage pointed out, the intrinsic strength of the Wayland Portland is so far in excess of the Saylor's as to still give a 5 to 1 mixture somewhat stronger.

The following is the mechanical analysis of the Mt. Morris sand as made at the State testing office:

	Per cent.
Retained by No. 20 sieve (400 meshes)	0.625
Retained by No. 30 sieve (900 meshes)	7.500
Retained by No. 50 sieve (2,500 meshes)	54.375
Retained by No. 74 sieve (5,746 meshes)	30.625
Retained by No. 100 sieve (10,000 meshes)	3.125
	96.250
Passed by No. 100 sieve	3.750
Total	100.000

Taking the percentages in the order of the amount passed by each sieve and we have:

	Per cent of the whole.
Passed by No. 20 sieve	99.375
Passed by No. 30 sieve	91.875
Passed by No. 50 sieve	37.500
Passed by No. 74 sieve	6.875
Passed by No. 100 sieve	3.750

This sand is absolutely pure quartz. Even the portion passing the No. 100 sieve shows clean and sharp when examined under the magnifier. Its entire freedom from vegetable matter, with its other good qualities, makes it an exceedingly valuable addition to the local resources available for this work.

The Wayland Portland neat gives a tensile strength of 542 pounds in seven days and 623 pounds in 28 days. As shown by the wire tests this cement is moderately slow setting — slow enough to give time for any necessary manipulation and handling of material, such as is required on any work of magnitude. The Saylor's Portland, on the other hand, is shown to be nearly as quick setting as the natural cements, a fact which might militate somewhat against its use on a large work like the proposed Genesee storage dam, where, on account of the distances to be covered, some little time for manipulation is imperatively necessary. But in making a final decision the fact should not be lost sight of that when mixed with sand into mortar the time of setting is greatly retarded.

For reasons which appear in detail in the tables, I do not consider any of the natural cements tested available for a work of this character, and I will, therefore, forbear spending any time discussing the results of the tests of these cements.

In addition to the tensile tests just referred to, the cements were also subjected to the hot test, as described by Mr. Faija, in the Transactions of the American Society of Civil Engineers, vol. XVII, page 218, and following:

Both of the Portland cements stand this test perfectly, while the results indicate that none of the natural cements tested would

be satisfactory for important dam work, such as we are now specially considering.

It has been generally assumed that comparative concrete tests 'iould agree in age as nearly as possible to the day, and, accord-.gly, it may be urged against these tests that the different)locks are not strictly comparable, by reason of varying some-'hat in age at the time of breaking. In order to show in his connection just how much importance attaches to exact greements of age Table No. 1 A has been prepared from the ›cords of the State cement testing office; and while this table ıows nothing which was not well known before, it still serves to ›resent saliently in this place that fact that the more rapid increase ın the strength of mortars is mostly confined to the first thirty lays, and that between ages of two and three months the differ-nce is not so great as to make comparisons entirely impossible. 'here is, however, a clear improvement with age at this period, nd the results of this table will enable one in comparing the con-rete tests to make the proper allowance. The Wayland Port-ınd tests, recorded in Table No. 1 A, are not from the same ımple as that used for the concrete tests, the tensile tests of hich for seven and twenty-eight days' periods are given in Table o. 1.

The manufacture of high grade Portland cements has recently ·come of considerable importance in this country, and the record a test·by days, up to thirty, of the Empire Portland, is, there-'e, also given in Table No. 1 A, by way of showing that there : now a number of high-grade American Portland cements, any : of which may be considered suitable for a work of this ıracter.

›ne point of interest brought out by the tests recorded in ·le No. 1 A, in comparison with these in Table No. 1, is as to effect of a slow setting cement on the strength of mortars n mixed with various proportions of sand. On examining the test records of the Wayland Portland, given in Table No. 1 A, ill be seen that this sample was considerably slower in setting that of which the tests are recorded in Table No. 1. Com-

paring the records of the two samples tested neat at seven days and twenty-eight, it appears that the sample of Table No. 1 gave a tensile strength of 542 pounds in seven days, and 623 pounds in twenty-eight days. The sample of Table No. 1 A gave 519 pounds in seven days, and 610 pounds in twenty-eight days, results somewhat less, as they should be, than those of the quicker setting sample of Table No. 1.

If we compare in the same way the results of the tests of these two samples of Wayland cement mixed with various proportions of standard quartz, as given in the tables, we find that the effect of the slower setting cement in retarding the development of strength is much more marked than in the case of the sampl tested neat. In 1 to 1 mortar the sample of Table No. 1 gave 43 pounds in seven days and 516 in twenty-eight days, while the slower setting sample of Table No. 1 A gave only 272 pounds in seven days and 386 pounds in twenty-eight days, and not until the end of five months does this sample give approximately the same strength as the quicker sample of Table No. 1 gave in twenty-eight days.

In the same way the two sets of tests may be compared up to the 5 to 1 mixtures, when it will be found that all exhibit the truth of the same general law. In the case of the 5 to 1 mixture the sample of Table No. 1 developed a tensile strength of 152 pounds in twenty-eight days, while the corresponding sample of Table No. 1 A gave a strength of 151 pounds in two months.

In taking the weights of the cements experimented upon the cubic foot has been used as the unit, instead of the bushel, as is ordinarily the case. The weights per cubic foot are as follows: Buffalo Cement Company's cement, 75.5 pounds; Newman's Akron, 76.5 pounds; Bangs & Gaynor's Fayetteville, 75.25 pounds; Newton's Rosendale, 76.0 pounds; Saylor's Portland, 102.65 pounds, and Wayland Portland, 109.25 pounds. These figures are the means of five trials, and represent the weight of the struck measure of cement in each case as shoveled from the barrel into the measure and slightly shaken. The computed weights of the struck Win-

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chester bushel are, for Saylor's Portland, 127.7 pounds, and for the Wayland Portland, 135.9 pounds.

These figures show at once that the Wayland Portland is a very heavy cement, comparing favorably in weight with the best foreign brands.

The proportions of water shown in Table No. 1, as used in gaging the cements for the tensile tests, are such as are ordinarily used at the State cement testing office for these cements. As to whether these are the best proportions for these particular cements the present writer is unable to say, as this point has not been experimented upon in the work done under his direction.

In the concrete tests the rule was to only use water enough to produce a stiff paste, except in a few cases, as noted, where the smallest possible quantity of water was used.

From Table No. 2 it appears that the trial blocks of concrete were molded from November 11, 1893, to December 12, inclusive. In every case an attempt was made to mix a large enough batch of concrete to represent the results of actual mixing in practice. To secure this result full measures were in every case taken, thus for a 1 to 3 mortar, 1 cubic foot of cement and 3 cubic feet of sand were used. If amounts of sand and cement were to be combined with 5 parts of broken stone, then 5 cubic feet of stone were measured out.

In regard to proportions of sand and cement and mortar, it may be remarked that it appeared to the present writer that the ordinary method of rating concrete as 1, 2 and 4, or 1, 3 and 5, or 1, 4 and 6, etc., meaning thereby that 1 part of cement and 2, 3 or 4 parts of sand, and 4, 5 or 6 parts of broken stone have been used, is not only unscientific, but that it is positively misleading, and its nearly universal prevalence has served to obscure, to a considerable extent the real points to be looked out for in the fabrication of concrete. In reality the relation is between the voids in the broken stone and the mortar.

In pursuance of this view the proportion of mortar to broken stone has been given in the records of these tests as a ratio, the quantity appearing in column (9) of Table No. 2 being the

quotient arising from dividing the number of cubic feet of mortar, measured after mixing, divided by the number of cubic feet of broken stone, with which the mortar was incorporated. The quantity in column (9) expresses, therefore, the percentage relation between the mortar and the stone. The relation which the quantity of mortar used bears to the voids is shown by the statement of results of determination of voids given on a preceding page.

A common rule is that the volume of mortar used should be somewhat in excess of the volume of the voids as measured before compacting. The present tests, however, indicate that the strongest concretes are secured when the volume of the mortar is very little, if any, in excess of the voids as measured before compacting or even a little less. This is strongly illustrated in the series from 39 to EE, in Table No. 2. But in making such concrete, special attention must be paid to the ramming, as upon its thoroughness will depend the success of the operation. In the case of using mortar in less quantity than the volume of the voids, obviously the ramming must be depended upon to reduce, by consolidation of the mass, the volume of the voids to somewhat less than what they would be with a smaller amount of ramming.

As will be seen by inspecting Table No. 2, in the majority of the tests, the mortar was made 42 per cent of the broken stone, this being about the per cent of voids in the hard stones before consolidation as per the determinations already cited. For the Genesee shales this proportion is somewhat too large, but it was considered best to use a relatively larger proportion of mortar with this aggregate than with the others, because by reason of its extreme friableness this stone grinds up considerably in the process of ramming. The comminuted shale acts to dilute the cement and weaken it. This result is strikingly exhibited in all the tests where it appears that the hard stone concretes are from one and one-half to twice as strong as the corresponding shale concretes with the same percentage of mortar. This is shown in detail in Table No. 4. The conclusion is then, that, if mortar were used in proportion to the smaller volume of voids in the

mixers. With this end attained, and through inspection gaging of the amount of water to varying temperatu

humidities, and thorough ramming, there ought to be no difficult in reaching these results always. It must be promised, howeve that the inspection be that of an expert in concrete fabrication.

The test blocks were prepared under the supervision of th present writer, who, although unable to be constantly presen from beginning to end, was still on the ground directing opera tions most of the time for the first week, and after that for the next ten days, three or four times each day, a half an hour at a time. At the end of this period the work was fully organized, and for the balance was left in charge of an intelligent assistant. Of the two men actually doing the work of manipulation, the principal one has had long experience in the use of Portland cements and may be considered, as ordinary masons go, an expert at such work. As indicated by Table No. 2, the tests blocks were made late in the fall, after the beginning of freezing weather, and in order to secure as nearly as possible uniformity of conditions, the water used in mixing was warmed to a temperature of 60 degrees. The mixing was according to the following formula, which was rigidly followed in every case. The proportion of cement, sand and stone having been determined upon beforehand, the stone was first measured out by itself on a separate platform and thoroughly washed clean of all impurities by water at a temperature of about 100 degrees. It was fully recognized, however, that nothing like heating the material should be permitted, and care was taken to so proportion the amount of warm water to varying air temperatures as to leave the stone at a temperature not higher than about 60 degrees when actually mixed with the mortar. In order to insure definite results in all matters relating to temperature, a thermometer was used at every stage of the operation.

After washing the stone, the sand was measured on to another platform, evenly spread, and finally the cement measured and also spread evenly over the sand. The mixture was then worked over and over until the cement was evenly distributed throughout the sand, the whole having taken such modified uniform color as was due to the varying colors of the different cements. The mixing was continued until absolutely no traces of streaks of cement through the sand could be seen. This operation being completed,

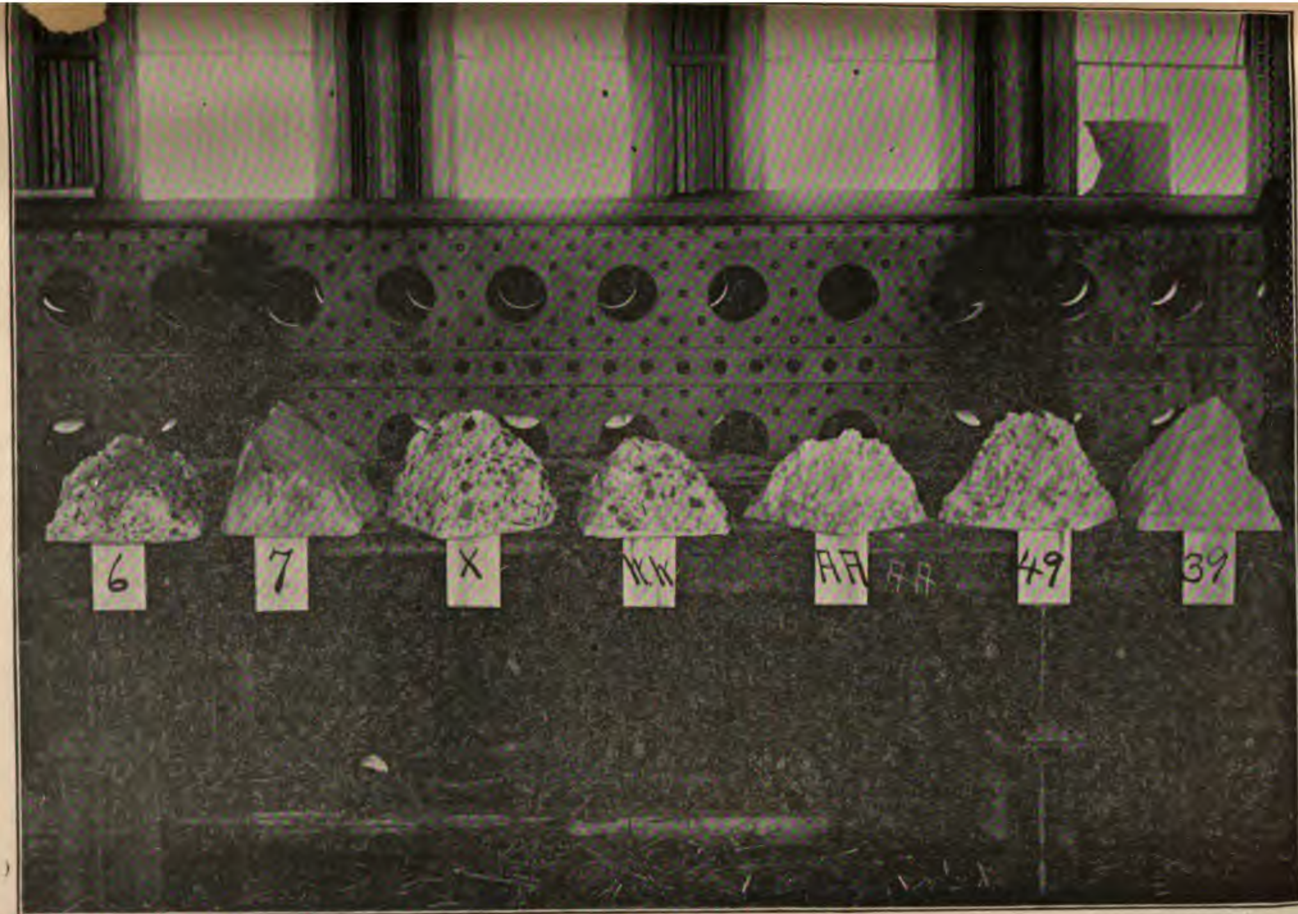

PLATE II.—ILLUSTRATING PYRAMIDAL FRACTURE OF CONCRETE BLOCKS.

enough water was added by sprinkling to bring the mortar to a stiff plastic mass. After thorough incorporation of the water the quantity of mortar to be used was measured from the pile and spread evenly over the broken stone, which had been previously leveled over the platform to the depth of 4 to 5 inches. The mixture of broken stone and mortar was then turned back and forth in accordance with General Gilmore's formula for mixing concrete, as given in his Limes, Cements and Mortars.

The molds used were constructed of thoroughly seasoned two-inch oak plank, and so arranged to go together with wedges as to be easily removed after the blocks had set. In order to prevent the concrete from sticking to the sides of the molds, they were well smeared with tallow before use. The molds having been got ready beforehand, the concrete was shoveled into them and rammed in layers of about three inches, as soon as the process of mixing on the platform was complete. After the first few days the blocks were in all cases made in duplicate, one block of each set going into water at a temperature of 60 degrees, and the other remaining in air at that temperature. In the tables the numbers (1, 2, 3, etc.) indicate the blocks set in water, and the letters (A, B, C, etc.) the blocks left in air. Up to and including the molding of the blocks the operations were all carried on in the open air, and the temperatures given in column (3) of Table No. 2 are the outside air temperatures at the time of mixing each block. As soon as mixed the blocks were carried into a basement, kept at the uniform temperature of 60 degrees, and allowed to stand until set. After setting had taken place and before removing the molds the top of each block was dressed true and smooth with mortar of the same cement and proportion of sand as used in the block itself. The sides of the molds were then removed, but the bottoms were left under the blocks; and after a further interval, depending upon rapidity of setting, those intended for the water test were placed in a tank, where they were entirely submerged. For both water and air blocks the blocks were left undisturbed on the bottoms until they were finally shipped for testing, January 26, 1894.

The compression tests, of which the details are given in Table No. 2, were made on the large horizontal 1,000-ton machine of the Phoenix Iron Company, at Phoenixville, Penn. For compression tests of this character the machine is arranged with two planed iron faces, one of which is fixed to the machine exactly at right angles to the line of motion, while the other face is free to move in a knuckle joint, which allows it to adjust itself to any slight lack of parallelism of the faces of the blocks to be compressed. In such tests it has been common to make the compression faces true by the use of plaster of Paris, but lacking facilities for applying the plaster of Paris on a plane metallic surface, as recommended by General Gilmore, it was concluded to dress the blocks up with neat cement, and, after setting of the same, to bring them to true surfaces by scraping with steel straight-edges. This treatment involves somewhat more labor than the plaster dressing, but the results were mostly satisfactory and the difference in expense is not material. Generally speaking the blocks adjusted themselves to the plates, satisfactorily, and it is believed that there are no material errors in the tests due to lack of uniformity of distribution of pressure over the entire area compressed. One or two cases, however, are noted in column (22) of Table No. 2.

In reducing the results to pressure on the square inch, the blocks have been assumed as exactly one foot area. The molds were very carefully and strongly made, as already noted, of two-inch oak, and the variations from a square foot area were so very slight that no material error arises from such assumption.

In order to determine the relative value of the Genesee shales for concrete in comparison with the harder Ridge, Portage and Nunda stones, it was considered desirable to make a number of tests of the actual amount of decrease of length which a number of the blocks underwent with given pressures applied. For this purpose a simple multiplying gage, the short arm of which was 4 inches in length, and the long arm 60 inches, was set in between the iron plates transmitting the pressure from the machine to the blocks. The proportionate lengths of the arms was as 1 to 15, whence the record made by the pointer at the

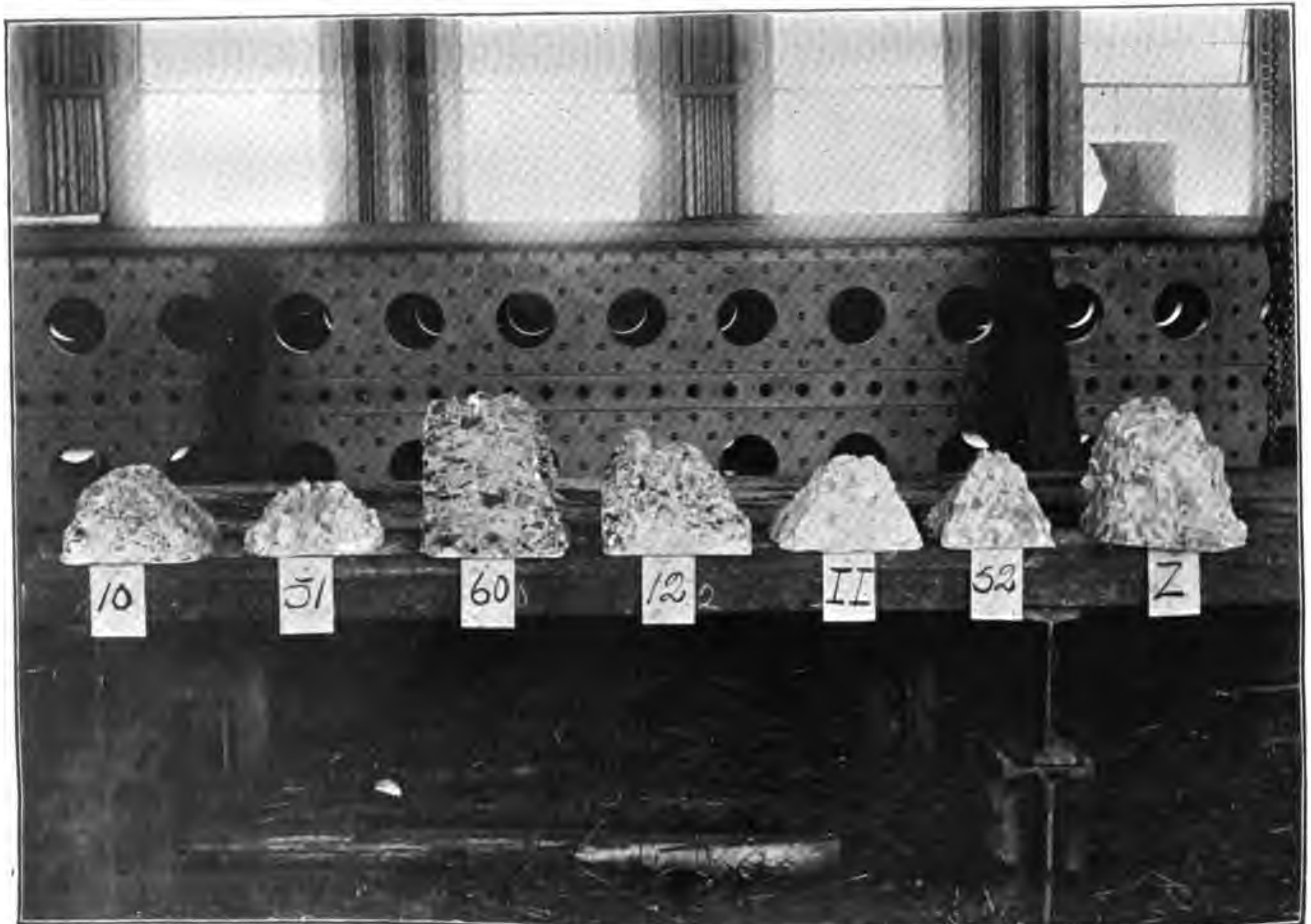

PLATE L—ILLUSTRATING PYRAMIDAL FRACTURE OF CONCRETE BLOCKS.

end of the long arm was 15 times the actual decrease in length. A fine scale graduated to one one-hundredth of an inch was used to measure the distance passed over by the pointer in each case, and a division of the indicated quantity by 15 gave the actual compression. In this way the results tabulated in column (21) of Table No. 2 have been obtained.

Without going into an elaborate analysis of these compression tests it will be sufficient to state that as a whole they indicate:

(1) That the compression decreases as the pressure per unit of area increases. (2) That the shale blocks compress about one and six-tenths times as much as those from the harder Ridge, Portage or Nunda stone. Table No. 3 is designed to show the relations of the two classes of stones, as regards compression, in detail.

In compiling Table No. 3, a few of the compression records, between 200 pounds on the inch and 650 pounds, have been omitted, as being so far away from the mean as to appear abnormal. For instance, it will be observed on referring to Table No. 1, that block No. 12, composed of a mortar of Wayland cement and sand 1 to 2, and shale, with mortar 43 per cent. of the measured quantity of shale, gave no compression at all between the limits of 200 pounds on the square inch and 650 pounds. From 650 pounds to 1,100 the compression was 0.004 inches, and from 1,100 pounds to 1,569, the point of first crack, the compression was also 0.004 inches. And while it may possibly be true that this block was actually incompressionable between the limits of 200 pounds on the square inch and 650, still, viewing the tests as a whole and especially taking into account that the mean of the fourteen shale blocks, included in Table No. 3, is 0.01346 inches between the limits considered, it must be considered doubtful if such an indicated record is entirely correct. It has, therefore, appeared allowable to reject this determination from the mean.

Again, block 55, composed of Wayland Portland cement and sand, 1 to 4, and Nunda stone, with mortar, 42 per cent. of the aggregate, gave a compression, between 200 pounds on the inch

and 650, of 0.03533. Also block 69, composed of Saylor's Portland cement and sand, 1 to 3, and Ridge stone, with mortar, 0.42 per cent. of the stone, gave 0.02677. Rejecting these two apparently abnormally large results, and we have 0.00825 inches as the mean of 23 blocks, between the limits of 200 pounds on the inch and 650. In view, therefore, of the considerable departure of blocks 55 and 69 from the mean, it appears proper to reject them, not, however, because it is entirely clear that the record is incorrect, but because the results of the tests, as a whole, the same as in the previous case of shale block No. 12, tend to cast some doubt upon them. In this connection it is proper to say that these apparently abnormal records were noticed when obtained, and, in each case, a close examination of the compression recording apparatus failed to show any defects therein which would account for the irregular results.

Taking the means, then, as given in Table No. 3, at 0.01346 inch for 14 shale blocks, and at 0.00825 inch for 23 hard stone blocks, and it results that as a mean the compression of the shale concretes between the limits taken in Table No. 3 was 1.63 times as great as for the blocks made from the harder Ridge, Portage and Nunda stone.

Table No. 4 has been prepared in order to show the relative breaking stresses of the shale blocks in comparison with blocks of similar mortar composition made from the harder stones. These comparisons are confined to the two Portland cements for the reason already indicated, that the results of the tests are to show the entire inadaptability of the natural cements to this work.

In regard to the comparative values of the Genesee shale and the hard stones, we learn from Table No. 4:

(1.) That Wayland cement in 1 to 1 mortar, in the proportion of 33 per cent. of the broken stone, gives a concrete, with the hard Ridge, Portage and Nunda stones, from 2.2 to 2.4 times as strong as the same composition of mortar with the Genesee shale.

(2.) That Wayland cement, in 1 to 2 mortar, of the proportions indicated in the table, gives, with the hard stones, from 1.1 to 1.5 the strength of the same mixture with the shale.

TABLE No. 3.

Comparison of compression tests of concrete made from Genesee shale and hard stone.

SERIAL NUMBER.	CEMENT. Brand.	CEMENT. Parts by measure in mortar.	Sand—part by measure in mortar.	BROKEN STONE. Quality.	BROKEN STONE. Ratio of broken stone to mortar.	Amount of compression—pressure from 200 pounds on the square inch to 650 pounds, in inches.	Remarks.
2	Wayland..	1	3	Shale...	0.67	0.01200	
3	do ..	1	3	do ...	0.83	0.01133	
4	do ..	1	2	do ...	0.58	0.00733	
5	do ..	1	4	do ...	0.80	0.02000	
6	do ..	1	4	do ...	0.53	0.01267	
9	do ..	1	5	do ...	0.53	0.02800	
10	do ..	1	5	do ...	0.43	0.01267	Sum of 14 shale blocks
39	do ..	1	1	do ...	0.33	0.00800	=0.18843, and
60	Saylor's ..	1	1	do ...	0.42	0.01733	$\frac{0.18843}{14}=0.01346$
TT	do ..	1	1	do ...	0.42	0.00153	
63	do ..	1	2	do ...	0.42	0.00400	
WW	do ..	1	2	do ...	0.42	0.01133	
67	do ..	1	3	do ...	0.42	0.02547	
68	do ..	1	3	do ...	0.42	0.01677	
Mean	....	......	......	....	......	0.01346	
40	Wayland..	1	1	Ridge...	0.33	0.00800	
41	do ..	1	1	Portage.	0.33	0.01000	
42	do ..	1	1	Nunda..	0.33	0.00333	
47	do ..	1	6	Portage.	0.42	0.00667	
48	do ..	1	2	do	0.42	0.01400	
49	do ..	1	2	Nunda..	0.42	0.01333	
51	do ..	1	3	Portage.	0.42	0.01067	
52	do ..	1	3	Nunda..	0.42	0.00633	
53	do ..	1	4	Ridge...	0.42	0.00667	
61	Saylor's ..	1	1	do	0.42	0.01067	
UU	do ..	1	1	do	0.42	0.00733	
62	do ..	1	1	Portage.	0.42	0.00633	
VV	do ..	1	1	do	0.42	0.00533	Sum of 23 hard-stone blocks
64	do ..	1	2	Ridge...	0.42	0.00900	=0.18966, and
XX	do ..	1	2	do	0.42	0.00867	$\frac{0.18966}{23}=0.00825$
YY	do ..	1	2	Portage.	0.42	0.00333	
66	do ..	1	2	Nunda..	0.42	0.01067	
ZZ	do ..	1	2	do	0.42	0.00167	$\frac{0.01346}{0.00825}=1.63$
CCC	do ..	1	3	Ridge...	0.42	0.01200	
70	do ..	1	3	Portage.	0.42	0.00933	
DDD	do ..	1	3	do	0.42	0.00400	
EEE	do ..	1	3	Nunda..	0.42	0.01533	
73	do ..	1	4	Portage.	0.42	0.00500	
Mean	....	......	......	....	......	0.00867	

(3.) That Wayland cement, in 1 to 3 mortars, of the proportion indicated in the table, gives, with the hard stones, from 1.4 to 1.6 the strength of the same mixture with the shale.

(4.) That Wayland cement, in 1 to 4 mortars, of the proportions indicated in the table, gives, with the hard stones, from 1.5 to 1.7 the strength of the same mixture with the shale.

(5.) That Wayland cement, in 1 to 6 mortar, of the proportions indicated in the table, gives, with the hard stones, from 2.0 to 2.3 times the strength of the same mixture with the shale.

(6.) That Saylor's Portland, in 1 to 1 mortars, in the proportion of 42 per cent of the broken stones, gives a concrete, with the hard stones, from 2.0 to 2.1 times as strong as the same composition of mortar in the same proportion with the Genesee shale.

(7.) That Saylor's Portland, in 1 to 2 mortar, in the proportion of 42 per cent of the broken stone, gives a concrete, with the hard stone, from 1.3 to 1.6 times as strong as the same composition of mortar in the same proportion with the Genesee shale.

(8.) That Saylor's Portland, in 1 to 3 mortar, in the proportion of 42 per cent of the broken stone, gives a concrete, with the hard stones, from 1.5 to 1.9 times as strong as the same composition of mortar in the same proportion with the Genesee shale.

(9.) That Saylor's Portland, in 1 to 4 mortar, gives, with the hard stone, a concrete from 1.7 to 1.8 times as strong as with the shale.

(10.) That Saylor's Portland, in 1 to 5 mortar, gives, with the hard stone, a concrete from 2.0 to 2.2 times as strong as with the shale.

(11.) That Saylor's Portland, in 1 to 6 mortar, gives, with the hard stone, a concrete from 1.2 to 1.7 times as strong as with the shale.

Taking the indications of these tests and the nearest approach to an equality of strength of the shale and hard stone, concrete is found with a 1 to 2 mortar for both of the Portland cements tested. For the Wayland, the relation is from 1.1 at the first crack, to 1.5 at the final stress; while for the Saylor's, 1 to 2, the relative strength is from 1.3 at the first crack to 1.6 at the final stress.

A considerable amount of concrete will be used in the proposed Genesee river storage dam for filling deep cross trenches in order to intercept the passage of water through the strata underneath the dam. The more nearly impermeable a concrete used for this purpose can be made the better it is adapted to the purpose for which it is used. Such a concrete should necessarily be as dense as the materials of which it is composed will admit, a condition only attained when the voids in the sand are entirely filled with the cement paste and the voids in the stone entirely filled with the mortar. An excess either of cement over the amount required to fill the voids in the sand, or of mortar over the amount required to fill the voids in the stone, makes the concrete more permeable and hence less valuable for stopping water. With the voids in the sand about 31 or 32 per cent of the total volume, a 3 to 1 mortar nearly fulfills the one necessary condition of impermeability. Probably, however, the point of greatest impermeability, so far as the mortar is concerned, lies somewhere between the proportion of 2 to 1 and 3 to 1, and it is satisfactory to observe, in the case of the Genesee shales, that the point of greatest strength of concrete is in close proximity to the point of greatest impermeability. This is of considerable practical importance, as the shale concretes can probably be used for making water-tight work in places where neither tensile nor compressive strength is required.

Taking the tests as a whole, and it appears that the final stresses of the blocks set in water are higher than those left in air, although there are exceptions to this, as will be seen on inspecting in detail either Table No. 2 or Table No. 5, which specially relates to this division of the subject discussed. Table No. 5 includes all the Wayland cement blocks from 39 to 55 inclusive, together with No. 78, and its air duplicate, LLL; it also includes all the Saylor's Portland blocks from 60 to 77 inclusive, together with No. 79, and its air duplicate, MMM; Nos. 78, LLL, 79 and MMM, it will be noticed, are composed of sand and cement only, without any broken stone, as are also blocks 43 and CC of the Wayland series.

The mean of the final stresses of all the Wayland cement blocks set in water is found to be 2,063 pounds on the square inch; while

for the duplicate air blocks it is 1,912 pounds on the inch, a mean excess of strength in favor of the blocks set in water over those left in air of 8 per cent. For the Saylor's Portland blocks the corresponding figures are: Water blocks, 1,578 pounds on the square inch; and for the air blocks 1,280 pounds. In this case the mean excess of strength of the water blocks over those left in air is 22 per cent.

In considering these results, two other points should be remembered:

(1.) That with one or two exceptions, which are confined to the natural cement blocks, the water and air blocks are exact duplicates (this is true of all the Portland cement blocks) both having been molded at the same time and from the same batch of concrete.

(2.) That the air blocks are with one or two exceptions lighter than the water blocks, as will be observed by referring to column (16) of Table No. 2.

In any work like the Genesee river storage dam, where, of necessity, concrete masonry must remain for a long time in air before either coming in contact with or being submerged in water, obviously that cement is preferable which comes nearest to developing its possible maximum strength under the ordinary conditions of actual practice, whatever they may be, rather than under the special conditions of a carefully regulated experimental test. From this point of view the tests show the superiority of the Wayland cement over the Saylor's Portland in a very marked degree, and while it is not considered that this point is absolutely established as between these two cements, still it is important enough to justify mentioning as decidedly worth attention in selecting a cement for any important work. On this point it may be also further remarked that the basement in which the air blocks were stored, until taken therefrom for shipment on January 26, 1894, was an ideal place for such storage. The tanks for immersion of the water blocks were also located therein and their large water surfaces, together with the leakage, which kept the cement floor of the room nearly covered with water during the whole period, furnished such a moist air as the conditions for

development of the greatest possible strength in air demand. This basement was maintained at a uniform temperature of 60 degrees F. during the whole period of storage therein. The car in which the blocks were shipped was also fitted with a stove and the temperature maintained as nearly as possible at 60 degrees F., until the blocks were finally taken to the testing room for breaking. The length of time the water blocks were out of the water and in air of a temperature of about 60 degrees F. in the car, may be seen in detail by reference to columns (12) and (14) of Table No. 2.

The means of 2063 and 1912 for water and air for the Wayland concretes, and of 1578 and 1280 for the Saylor's Portland, as given in Table No. 5, also indicate a superiority of the Wayland over the Saylor's. On this point it may be observed that while the Wayland blocks, as whole, do show somewhat higher than the Saylor's, still a final conclusion could only be drawn properly from a comparison of the same number of blocks of the same composition. In this view Table No. 5 makes a more favorable showing than it otherwise would for the Wayland blocks. The relative ages may also be taken into account in any final decision. It may be pointed out, however, that the indication of the concrete tests is, in this particular, in accord with that of the tensile tests as shown in Table No. 1.

The fractures developed by these blocks in breaking were for the strong ones, in accordance with the observations of other experimenters, pyramidal in form. As no special practical result is deducible from the observations made on this point, the subject is not pursued any further than to call attention to plates I and II, illustrating a few of the typical forms which were photographed at the time of the tests. On plate II, however, for block 39, read 79.

In regard to the pressures producing first crack and final stress, as given in Table No. 2, it may be stated that the friction of the testing machine has been allowed for in the reductions; the quantities under these heads, therefore, represent the actual pressure, as nearly as they can be obtained from the Phoenix Company's machine.

PLATE III — CONDITIONS OF CONCRETE BLOCKS EXPOSED TO FREEZING ON MARCH 17, 1894.

TABLE No. 5.

Relative strength of concrete blocks set in water and in air.

In Water.		In Air.		Cement.			Broken Stone.		
Serial number.	Final stress.	Serial letter.	Final stress.	Brand.	Parts by measure in mortar.	Sand, parts by measure in mortar.	Quality.	Ratio.	Remarks.
39....	1,569	Y.....	1,300	Wayland .	1	1	Shale ...	0.33	
40....	3,709	Z ....,	3,339	do .	1	1	Ridge ..	0.33	
41....	2,9-8	AA ...	3,339	do .	1	1	Portage.	0.33	
42....	2,089	BB....	2,891	do .	1	1	Nunda..	0.33	
43....	4,483	CC ...	4,280	do .	1	1	....	....	Sand and cement only. No broken stone.
44....	695	DD ...	482	do .	1	6	Shale ...	0.33	
45....	986	EE....	683	do .	1	6	Portage.	0.33	
46....	672	FF ...	650	do .	1	6	Shale ...	0.42	See note in col. 22 of Table No. 2 relating to 46 and 47.
47....	2,174	GG ...	1,882	do .	1	6	Portage.	0.42	
48....	2,533	HH...	2,555	do .	1	2	Portage.	0.42	
49....	2,398	II.....	2,331	do .	1	2	Nunda..	0.42	
50....	1,602	JJ....	1,210	do .	1	3	Ridge ..	0.42	
51....	1,860	KK...	1,658	do .	1	3	Portage.	0.42	
52....	2,308	LL ...	1,681	do .	1	3	Nunda..	0.42	$\frac{2083}{1912} = 1.09$
53....	1,686	MM...	1,367	do .	1	4	Ridge ..	0.42	
54....	1,524	NN ...	1,322	do .	1	4	Portage.	0.42	
55....	1,233	OO ...	1,098	do .	1	4	Nunda..	0.42	
78....	2,465	LLL..	2,353	do .	1	2	....	....	Sand and cement only. No broken stone.
	2,083	......	1,912	....	....	....	....	....	= Means.
60....	1,367	TT....	1,501	Saylors ...	1	1	Shale ...	0.42	
61....	3,451	UU ...	3,025	do ...	1	1	Ridge ..	0.42	
62....	3,126	VV....	2,308	do ...	1	1	Portage.	0.42	
63....	1,367	WW ..	1,053	do ...	1	2	Shale ...	0.42	
64....	2,127	XX....	1,681	do ...	1	2	Ridge ..	0.42	
65....	2,107	YY ...	1,883	do ...	1	2	Portage	0.42	
66....	2,039	ZZ....	1,501	do ...	1	2	Nunda..	0.42	
67....	807	AAA..	762	do ...	1	3	Shale ...	0.42	
68....	941	BBB ..	784	do ...	1	3	Shale ...	0.42	
69....	1,613	CCC ..	1,389	do ...	1	3	Ridge ..	0.42	
70....	1,636	DDD..	1,501	do ...	1	3	Portage.	0.42	
71....	1,725	EEE..	1,389	do ...	1	3	Nunda..	0.42	
72....	661	FFF ..	627	do ...	1	4	Shale ...	0.42	
73....	1,109	GGG..	1,154	do ...	1	4	Portage.	0.42	
74....	483	HHH..	493	do ...	1	5	Shale ...	0.42	
75....	1,255	III ...	919	do ...	1	5	Portage.	0.42	$\frac{1577}{1327} = 1.19$
76....	471	JJJ...	381	do ...	1	6	Shale ...	0.42	
77....	807	KKK..	650	do ...	1	6	Portage.	0.42	
79....	2,880	MMM..	2,219	do ...	1	2	....	....	Sand and cement only.
	1,577	......	1,327	....	....	....	....	....	= Means.

An experiment was made in a very rough way as to whether these concretes would stand winter weather when freshly made. For this purpose the surplus quantities of each mixing were made into a series of cubes of three feet, these cubes being built up in thin layers, well rammed, from day to day, as the tests went on. Plate III is from a photograph showing the appearance of these blocks March 17, 1894. Block No. 1 was composed of Wayland cement for the first foot at the bottom, with the balance natural. No. 2 was about the same, except there was a layer of Portland cement concrete about one inch thick at the top. Block No. 3 was natural cement concrete, except a layer of Portland cement concrete six inches thick, about eight inches from the top. No. 4 was composed entirely of Portland concrete, except a layer of natural cement concrete about six inches thick and about six inches from the top.

In Block No. 3 the layer of Portland concrete appears thoroughly indurated and, so far as can be observed, entirely uninjured by frost.

In Block No. 4 the Portland cement concrete is uninjured, while the layer of natural cement near the top has crumbled the same as in the other blocks.

The boxing was allowed to stand around all these blocks until after the completion of the tests in December. They were, therefore, protected from the action of storms at the sides until after thorough setting had taken place. The air temperatures during the days when these blocks were in process of making are shown in column (3) of Table No. 2. The nights were, of course, much colder.

The test by exposure to freezing indicates one point wherein the Portland cements as a class are superior to the natural, namely, they may be laid in moderately cold weather and, provided as small an amount of water as possible is used, no ill-effect will be observed. The water is the destructive agent in freezing weather, and by reducing it to a minimum there will remain, after chemical combination, little or none to disrupt. This practice, too, will be of advantage by adding to the strength of the mixture, as it is now

well understood that an access of strength of the concrete follows a reduction of the amount of water used in mixing; for the greatest strength the smallest possible quantity of water should be used. For very great strength the quantity of water may be so far reduced as to cause the mortar to resemble damp earth. When such mortar is added to broken stone, which have first been well wetted and allowed to drain, the water may by thorough ramming be still flushed to the surface in a very thin film.

In freezing weather, therefore, the practice which prevents injury to the work will also be the proper practice for developing the greatest possible strength.

It has been a common practice to add salt to the water used in mixing in freezing weather in the proportions of about one per cent of saturation for each degree below the freezing point. The weight of evidence is that for well proportioned Portland cement this practice is entirely wrong — much better results will be obtained by the practice indicated in the foregoing.

We come, now, to the final point of the study, namely, to answer the questions proposed at the beginning as to the adaptability of the various materials tested for use in concrete in the construction of the proposed Genesee storage dam. The formal answers are as follows:

(1.) As regards the Genesee shales, they are not suitable for the main dam, or any portion of it which will be subjected to severe strains. At present there appears to be no reason why they can not be used for filling cross-trenches and for sheeting the sides and bottom, where the only object to be attained is the making of impermeable work.

Inasmuch as there is a considerable quantity of such work estimated, their use, even when restricted to this one feature, will be the source of an economy of from $40,000 to $50,000.

(2) As regards the Ridge, Portage and Nunda stones, the tests show that all of them are suitable for the aggregate of high-grade concrete. There is no good reason why the proposed storage dam can not be mostly constructed of a concrete fabricated from some one of these stones. In connection with rubble masonry, their

TABLE No. 6.

Results of compression tests of Pennsylvania, Ridge, Portage ana Nunda stone.

QUALITY OF STONE.	Serial number.	Dimensions of block.	Weight of block in pounds.	Weight per cubic foot in pounds.	First Crack. Pounds on the square inch.	First Crack. Net tons on the block.	Final Stress. Pounds on the square inch.	Final Stress. Net tons on the block.	Explanations.
Pennsylvania sandstone.....	1	6"×12"×12"	71.5	143.0	4,280	308.2	6,678	480.8	This block was dressed on all its faces. Pressure applied to the 144-inch faces at right angles to beds. Broke with loud report.
Pennsylvania sandstone.....	2	6"×12"×12"	71.75	143.5	....	....	4,268	153.8	Dressed on all faces. Pressure applied to 72-inch faces parallel to beds. Pieces cracked off before pressure reached 95 tons.
Pennsylvania sandstone.....	3	6"×12"×12"	81.0	162.0	2,936	211.4	9,166	659.9	Dressed on 144-inch faces only. Rock face on balance of sides. Pressure applied on 144-inch face at right angles to beds.
Pennsylvania sandstone.....	4	6"×12"×12"	81.25	162.5	3,115	224.3	10,129	729.3	Same as (3).
Pennsylvania sandstone.....	5	12"×12"×12"	142.0	142.0	2,219	159.7	4,437	319.5	Dressed on all faces. Pressure applied at right angles to beds.
Ridge........................	6	9"×9"×9"	70.25	166.5	3,147	127.5	8,286	335.6	Dressed on all faces. Pressure applied at right angles to beds
Portage	7	12"×12"×12"	155.0	155.0	4,460	321.1	7,709	555.0	Dressed on all faces. Pressure applied at right angles to beds
Nunda........................	8	8"×12"×12"	106.0	159.0	4,347	313.0	5,916	426.0	Dressed on all faces. Pressure applied on 144-inch face at right angles to beds.

use for such purpose will be the source of an economy of about $300,000.

(3.) As regards the natural cements the tests show that none of them are suitable for a work of this character. Their general unreliability would of itself condemn them for use in a dam 130 feet in height. On this point reference may be made to Table No. 2, where it will be seen that out of a total number of natural cement test blocks of 78, nearly one-third of the whole, or 25, failed to give any result whatever.

Block F, as shown in column (22) of Table No. 2, was accidentally destroyed in the testing machine, and is not included in the number as failing to give any record. This statement is intended to include only those which were found to be cracked or which crumbled or were easily broken with light blows of the hammer when taken from the water. Moreover, it is significant that with one exception the failures of the natural cement blocks were all among the water blocks.

If we examine the detailed record of the Portland cement blocks as given in Table No. 2, we find that out of a total number of 96 made, not one failed to give a useful result in the tests. This fact alone establishes beyond all question the great superiority of the Portland cements over the natural for any work requiring a reliable material under any and all circumstances.

In reference to these two classes of cement it may be stated that every attempt was made to get the best results in these tests which the several materials were capable of yielding, and while the proportion of failures among the natural cements appears unduly large, still an examination of the records, for two or three years back, in the State testing office, easily convinces one that these results are on the whole not specially exceptional. In making this statement it is not intended to assert that about one-third of all the tensile tests of natural cements are failures, although the tests of the same cement frequently shows such great variations from different samples as to easily lead to a positive conclusion as to their extreme unreliability. In addition the records show a considerable proportion of absolute failures.

In the present case it may be concluded, too, that the water bath was a severe test for concrete blocks made from the natural cements.

The conclusion is, then, that the two American Portland cements tested are suitable for the work in hand. Their relative values have been discussed to some extent throughout the report.

(4.) The detailed tensile tests of Table No. 1 show that the Mt. Morris sand is of a quality suitable for an important work of this magnitude.

In using concrete on a large scale, as in a work of this character, mechanical mixing will preferably be used, not only on the score of economy of labor, but on account of yielding more thorough results. As we have seen, it is important that the mixing proceed according to a definite formula, in order that such results may be secured. The necessary plant for this purpose would properly include:

(1) A series of bins for storing cement, sand and broken stone together with a tank for storing water, from all of which the proper quantities of each may be fed to the mixing machine by arrangements under the control of one person.

(2) A mixing machine which admits of (a) the dry mixing of the cement and sand in the proper proportions; (b) the thorough mixing of the cement mortar, after the addition of the water; and (c) the separate mixing of the mortar with the aggregate.

(3) Mechanical arrangements for immediately carrying the concrete in quantity from the mixing machine to its final place in the work.

The delivery of all the material to be used in construction at the top of the high bank, in the manner proposed in the preliminary report would render feasible arrangements embodying these conditions at a minimum of expense.

As a final point in the concrete study it may be stated that after reviewing the whole subject in its various phases the present writer has arrived at the conclusion, that, in order to provide for expansion and contraction in the direction of the length, the work should be built in large blocks placed far enough apart to admit of putting up and taking down the boxing; the spaces

between, to be filled later on with concrete thoroughly rammed. The large blocks may be set to break joints both vertically and horizontally, thereby avoiding horizontal joints across the whole width of the wall.

Concluding the subject of concrete study, it may be stated that the tests, as a whole, while giving many valuable results, are hardly as complete as could be desired. They lack somewhat in symmetry, due not only to the large number of points requiring investigation, but to the small amount of money as well as time at my disposal for this part of the work. In making them as they stand, it was assumed, that in case the project was carried out, and it was concluded to use concrete for the main portion of the work, an opportunity for studying any questions requiring further consideration would be afforded. It is, therefore, suggested, in case this work goes on, that additional studies in reference to the economical limit of the quantity of mortar in relation to the voids in the aggregate be made.

For such final studies it seems unnecessary to go outside of the Portland cements. So far as can be foreseen, the cost of the desirable additional studies would be small. The present tests have not cost to exceed about $1,500.

Some of the more interesting results of the tests are shown graphically in Plates IV and V, which are self-explanatory.

A few compression tests have also been made of the Pennsylvania sandstone and of blocks from Ridge, Portage and Nunda quarries. The results are given in Table No. 6. Blocks Nos. 1 to 5, of the Pennsylvania sandstone, were all broken with pressure at right angles to the beds, except No. 2, on which the pressure was applied parallel to the natural beds. Blocks 3 and 4 were dressed on the beds and left rock face at the sides, which accounts not only for the excessive weight of these two blocks, but, probably, for the large final stress. The Pennsylvania sandstone are rather coarse grained.

Block No. 6, a nine-inch cube from the Ridge quarry, actually weighed 70.25 pounds, which gives a calculated weight per cubic foot of 166.5 pounds. The final stress on this block was 8,286

pounds on the square inch. The important points of the Portage and Nunda blocks are sufficiently shown by the tabulation.

We may now take up the detail of the water pressure tests, of which a general description has been given in the preliminary report. The following condensations from the daily journal of these tests will serve to illustrate the methods and results obtained:

September 21, 1893.— Finished first drill hole, XX3, to depth of 42 feet in rock, or to 67.9 feet from top of casing (elevation of bottom of drill hole, 524.7). At depth of 7 feet in the rock (elevation 561.7) the wash water disappeared — that is, stopped returning to the surface through the casing, as it should, so long as everything below is water-tight. The inference is that there are seams through which the water runs away, although it may possibly escape under the shoe at the top of the rock. The appearance of the drill rods, however, was such as to indicate the presence of strong sulphur water. After removing drill the water was found standing in casing at 12 feet below surface (stood at elevation of 580.6) and could not be made to stand permanently higher, even when forced down in quantities under pressure from pump. A common suction pump was set 25 feet down (at elevation of 567.9). On pumping at rate of 5 to 6 gallons per minute, water in hole soon fell several feet. After about 15 minutes the water pumped showed strong with sulphur, and was also deeply discolored with the drill cuttings. This apparently indicated not only the presence of seams containing sulphur water, but that the escape of the wash water, referred to in the foregoing as taking place while drilling, had been into seams from which when the action was reversed, the cuttings were easily brought back.

September 26.— In afternoon set seed bag two feet long in drill hole XX3. (Lower end of bag at elevation 564.6. Top of rock, 568.7.)

Wednesday, September 27.— Connected pump with one-inch pipe leading down through seed bag and ran at full capacity with 60 pounds of steam. Water pressure at surface of ground, as indicated by gage, 20 pounds. Water at this pressure was forced below seed bag for an hour, apparently without effect. The conclusion is that at some point below elevation 564.6 the rock is open enough to allow water to run away.

September 30.— Made further tests of drill hole XX3. Seed bag had been set to 40 feet below top of casing (at elevation of 552.6, or 16.1 feet below top of rock). Pressure as indicated by gage at surface of ground, 32 feet from top of casing, 22 pounds. Total length of one-inch pipe beyond pressure gage, 76 feet.

Under these conditions hole took full capacity of pump with 60 pounds steam pressure for one-half hour without showing any increased pressure.

October 6.— Tested drill hole ZZ3. Seed bag, 35 feet down (at elevation of 554.0). Pressure gage at surface of ground showed 5 pounds pressure. Seed bag leaked and test was in consequence without definite results.

October 7.— Again tested ZZ3, with same results as on previous day. Thereupon pulled out old seed bag and set new one.

October 9.— Again tested ZZ3. Found seed bag tight. With 60 pounds steam pressure and full capacity of pump, gage showed 20 pounds. When pump was first started water rose in casing to surface of ground and overflowed, but quickly dropped back several feet. There seems to be no doubt but that seed bag was tight this time and that, therefore, the water must have come up through crevices in the rock around the seed bag.

The preceding tests having shown that the seed bag was too cumbersome for this work, a rubber packer was procured and the balance of the tests made with its assistance. This was so arranged, with stand pipe leading to bottom of hole, as to instantly pack tight on the application of pressure at the surface of the ground. By its use definite results were obtained, as described in the preliminary report, which would have been impossible of attainment with the seed bag.

October 17.— Tested drill hole YY4, using rubber packer, which was set 50 feet from top of casing (at elevation of 539.5). On first starting pump gage showed 60 to 70 pounds; pressure gradually rose to 110 pounds. At this latter pressure the hole took all the water the pump could deliver.

Before starting pump, put in hole six ounces of aniline red and eleven ounces of permanganate of potash. Stationed men on river in boats but could find no trace of this color.

After pumping for an hour with packer at elevation 539.5, disconnected and found that water ran slowly from top of pipe about 5 feet above surface of ground (elevation 594.0), thereby showing that a small head had been gained at the sides.

Packer was then raised to an elevation of 559.5 (top of rock at 565.2), a pound of aniline red added and pump again connected. With pump at full capacity, pressure gage now showed only 20 pounds pressure, and no more could be gained however rapidly pump was run. The clear inference is that between elevations 539.5 and 559.5 there are seams or fissures which allow water to flow out of drill hole when under about 20 pounds pressure.

No trace of the coloring matter could be found along the river in either case.

Judging from the indications of the water pressure tests, as well as from the condition of the core, the first 10 to 15 feet of rock at Dam Site No. 2, especially on the east side, is somewhat seamy and broken up (see the cores in verification of this view).

October 19.— Tested drill holes ZZ1. Packer was first set 19 feet above bottom (elevation of 532.5), stalled pump at 100 pounds pressure. Raised packer gradually, packing it at every few feet by setting pressure above against pressure of water from below. In this way the hole was tested for its entire length and found to stand, as stated, 100 pounds at the bottom, and from 40 to 50 pounds in the upper part. Best results in the upper section of any yet tested.

October 31.— Tested horizontal hole at foot of Hogback. Set packer 87 feet in., or eight feet from end. On starting pump, gage showed 100 pounds and gradually rose to 140 pounds. Released packer and stopped every 10 feet until 54.5 feet from bottom was reached. At this point gage dropped to 100 pounds, but in one-half hour again advanced to 140 pounds, and finally in 15 minutes more to 150 pounds, where it remained for one-half hour anl then dropped to 60 pounds, steam remaining the same. In an hour and forty-five minutes pressure showed 40 pounds. At this point water dripped from the side of the Hogback for some distance to the south.

November 2.— Repeated this test with packer 55 feet from bottom of hole, and with four quarts of wheat bran below packer. Pumped with 100 pounds pressure for two hours without effect.

November 2.— Tested hole 23 + 42 W. 250, at Hogback location. Hole 84 feet deep, 14 feet to rock (elevation of bottom 503.4; top of rock 571.4). Set packer 8.5 feet from bottom. Gage showed 165 pounds. Raised packer to elevation 524.4 and pressure dropped to 80 pounds. Disconnected and put in four quarts of bran, whereupon pressure rose to 170 pounds. Raised packer to elevation 534.0 and still maintained same pressure. At elevation 536.0 pressure dropped to 100 pounds and remained at that point even after the addition of 5 quarts of bran. Pressure finally fell to 60 pounds and remained there for three and one-half hours. While pumping this hole water ran from casing at 23 + 42 W. 350.

Also put two pounds of permanganate of potash in hole, no trace of which could be discovered along the river.

November 4.— Tested 23 + 42 W. 350 at Hogback location. Set packer 10 feet from bottom (elevation of 518.0), got 40 pounds pressure on gage. Added

4 quarts of bran without effect on the pressure. In two and one-half hours the pressure gradually rose to 65 pounds. Coloring matter was added, and showed in water flowing from casing at hole 23 + 42 W. 250. On stopping pump it was found that water pumped into hole had acquired a back pressure of 20 pounds. On disconnecting, water ran from pipe for one hour and forty-nine minutes. This outflowing water showed coloring matter for fifteen minutes.

This test indicates not only a connection between holes 23 + 42 W. 250, and this one under the river bed, and independent of it; but also shows backing up, probably in vertical seams, at the sides of the gorge. A number of other tests at this site gave the same result.

November 24.— Tested B. 40 + 70 W. 750 at Dam Site No. 1. Set packer 6 feet from bottom. Pressure rose to 180 pounds, pump stalled. Raised packer 10 feet, or to 16 feet from bottom, when pressure at first rose to 170 pounds, but in a few minutes fell to 120 pounds, where it remained for ten minutes, and finally fell to 100 pounds. Uncoupled and added bran, when pressure rose from 100 to 120 pounds. Raised packer to 26 feet from bottom and gage showed 40 pounds. Again added bran and gage rose to 50 pounds. With packer at this elevation gas issued from casing at hole B. 40 + 70 W. 850. Upon raising packer 2 feet more, larger quantities of gas flowed from that hole. The packer was raised and lowered several times, with like results, showing a connection between the two holes at about elevation of 548.0.

The foregoing are the details of a number of the pressure tests. The general deductions from these various tests have been so fully given in the preliminary report as to make further discussion of them unnecessary here.

In regard to the estimates of cost of which the footings are submitted in the preliminary report, it may be stated that, on revision, it appears the footings for all the rubble masonry dams estimated for Sites 1 and 2 could be reduced somewhat, but the estimate for an earth dam at the Hogback would, perhaps, need to be increased. The results of the concrete tests, as already exhibited, are, however, so satisfactory, and lead, with other modifications of plan, to such material reductions of cost as to render further consideration of either an earth dam at the Hogback location, or of rubble masonry dams at Sites 1 and 2 unnecessary. The proposed use of concrete construction, therefore,

narrows the choice to Sites 1 and 2, where the question of cost may properly be made, to some extent, subordinate to that of absolute safety and durability.

The following are the detailed estimates for a series of dams at these two sites to be built either wholly, or nearly wholly, of concrete, or with rubble masonry faces and concrete cores as the case may be. As will be noted, on inspection, these estimates provide for clearing the timber from the whole reservoir and for the construction of the necessary transportation line.

Estimated Cost of Concrete Dam at Site No. 1, 130 *Feet in Height.*

Two thousand six hundred and twenty acres of land, at $30 per acre	$78,600
Nine hundred acres of clearing, at $20............	18,000
Three acres of clearing and grubbing, at $100......	300
Changing bridge and highway at St. Helena....	7,500
Bailing and draining whole work................	75,000
Grouting in foundation	30,000
One hundred thousand cubic yards foundation excavation (earth), at 30 cents	30,000
Sixty-six thousand cubic yards foundation, excavation (rock), at $1	66,000
Fifteen thousand cubic yards, granite masonry, at $20	300,000
Eighty thousand cubic yards concrete, at $5.50..	440,000
One hundred and ninety thousand cubic yards concrete, at $4	760,000
Thirty thousand cubic yards concrete, at $3......	90,000
Seven thousand cubic yards rubble masonry, at $7..	49,000
Six hundred and fifty cubic yards coping, at $40....	26,000
One thousand three hundred and fifty cubic yards coping, at $20	27,000
One thousand cubic yards clay puddle, at $1......	10,000
Three thousand five hundred cubic yards riprap (large stone), at $4	14,000
Gate-house building	20,000

Gates and operating machinery	$40,000
Transportation line	50,000
Add for contingencies and superintendence	318,600
Amount	$2,450,000

With sandstone faces throughout, except for the spillway, where granite is provided, and concrete core, the estimated cost of this dam would be $2,590,000.

Estimated Cost of Concrete at Dam Site No. 1, *Built to Height of* 58 *Feet, but Susceptible of Extension to* 130 *Feet.*

One thousand six hundred and twenty acres of land, at $30	$48,600
Five hundred acres of clearing, at $20	10,000
Three acres of clearing and grubbing, at $100	300
Bailing and draining whole work	75,000
Grouting in foundation	30,000
Ninety-five thousand cubic yards foundation excavation (earth), at 30 cents	28,500
Fifty-nine thousand cubic yards foundation excavation (rock), at $1	59,000
Nine thousand cubic yards granite masonry, at $20,	180,000
Forty-eight thousand cubic yards concrete, at $5.50,	264,000
One hundred and forty thousand cubic yards concrete, at $4	560,000
Twenty-five thousand cubic yards concrete, at $3	75,000
Seven hundred cubic yards coping, at $20	14,000
Ten thousand cubic yards clay puddle, at $1	10,000
Three thousand five hundred cubic yards riprap, at $4	14,000
Temporary gate-house building	8,000
Gates and operating machinery	35,000
Three hundred thousand feet B. M. of oak timber in work, at $35	10,500
Transportation line	50,000
Add for contingencies and superintendence	228,100
Amount	$1,700,000

With sandstone faces throughout, except for the spillway, where granite is provided, and concrete core, the estimated cost of this dam would be $1,780,000.

Estimated Cost of Completing a Concrete Dam at Site No. 1, *Built Originally to Height of* 58 *Feet, but Susceptible of Extension to* 130 *Feet; Cost of Completing Between* 58 *Feet and* 130 *Feet.*

One thousand acres of land, at $30	$30,000
Four hundred acres of clearing, at $20	8,000
Changing bridge and highway at St. Helena	7,500
Five thousand cubic yards foundation excavation (earth), at 30 cents	1,500
Seven thousand cubic yards foundation excavation (rock), at $1	7,000
Six thousand cubic yards granite masonry, at $20	120,000
Thirty-two thousand cubic yards concrete, at $5.50	176,000
Fifty thousand cubic yards concrete, at $4	200,000
Five thousand cubic yards concrete, at $3	15,000
Seven thousand cubic yards rubble masonry, at $7	49,000
Six hundred and fifty cubic yards coping, at $40	26,000
Six hundred and fifty cubic yards coping, at $20	13,000
Permanent gate-house building	20,000
Additions to machinery	10,000
Contingencies and superintendence	117,000
Amount	$800,000

With sandstone faces throughout, except for the spillway, where granite is provided, and concrete core, the estimated cost of this dam would be $860,000.

Estimated Cost of Dam at Site No. 1, 100 *Feet in Height.*

Two thousand two hundred and fifty acres of land, at $30	$67,500
Seven hundred acres of clearing, at $20	14,000
Three acres of clearing and grubbing, at $100	300
Bailing and draining whole work	65,000
Grouting in foundation	25,000

Ninety-six thousand cubic yards foundation excavation (earth), at 30 cents	$28,800
Fifty thousand cubic yards foundation excavation (rock), at $1	50,000
Ten thousand cubic yards granite masonry, at $20..	200,000
Forty thousand cubic yards concrete, at $5.50	220,000
One hundred and ten thousand cubic yards concrete, at $4	440,000
Twenty-five thousand cubic yards concrete, at $3..	75,000
Five thousand cubic yards rubble masonry, at $7..	35,000
Five hundred and ninety cubic yards coping, at $40,	23,600
Six hundred and fifty yards coping, at $20	13,000
Seven thousand cubic yards clay puddle, at $1	7,000
Three thousand cubic yards riprap, at $4	12,000
Gate-house building	15,000
Gates and operating machinery	30,000
Transportation line	50,000
Contingencies and superintendence	208,800
Amount	$1,580,000

With sandstone faces throughout, except for the spillway, where granite is provided, and concrete core, the estimated cost of this dam would be $1,650,000.

Estimated Cost of Concrete Dam at Site No. 1, 58 *Feet in Height.*

One thousand five hundred acres of land, at $30...	$45,000
Five hundred acres of clearing, at $20	10,000
Bailing and draining whole work	55,000
Grouting in foundation	20,000
Thirty-seven thousand cubic yards foundation excavation (earth), at 30 cents	11,100
Forty-eight thousand cubic yards foundation excavation (rock), at $1	48,000
Six thousand cubic yards granite masonry, at $20..	120,000
Sixteen thousand cubic yards concrete, at $5.50	80,000
Forty-seven thousand cubic yards concrete, at $4 ..	188,000

Eighteen thousand cubic yards concrete, at $3	$54,000
Three thousand cubic yards rubble masonry, at $7..	21,000
Two hundred and fifty cubic yards coping, at $40..	10,000
Four hundred cubic yards coping, at $20	8,000
Six thousand cubic yards clay puddle, at $1	6,000
Three thousand cubic yards riprap, at $4	12,000
Gate-house building	12,000
Gates and operating machinery	25,000
Transportation line	50,000
Add for contingencies and superintendence	124,900
Amount	$900,000

With sandstone faces throughout, except for the spillway, where granite is provided, and concrete core, the estimated cost of this dam would be $930,000.

Estimated Cost of Dam at Site No. 2, 130 Feet in Height.

Two thousand four hundred acres of land, at $30 per acre	$72,000
Eight hundred and fifty acres of clearing, at $20..	17,000
Ten acres of clearing and grubbing, at $100......	1,000
Changing bridge and highway at St. Helena.....	7,500
Bailing and draining whole work................	50,000
Grouting in foundations	40,000
Seventy-five thousand cubic yards foundation excavation (earth), at 30 cents....................	22,500
Forty-five thousand cubic yards foundation excavation (rock), at $1	45,000
One hundred and fifty thousand cubic yards earth excavation in spillway, at 18 cents............	27,000
Four hundred and twenty-five thousand cubic yards rock excavation in spillway, at 70 cents........	297,500
Two thousand cubic yards granite masonry, at $20..	40,000
Seventy thousand cubic yards concrete, at $5.50..	385,000
Two hundred and twenty thousand cubic yards concrete, at $4	880,000

Forty thousand cubic yards concrete, at $3........	$120,000
Seven thousand cubic yards rubble masonry, at $7..	49,000
Two thousand cubic yards coping, at $20.......	40,000
Ten thousand cubic yards clay puddle, at $1......	10,000
Gate-house building	20,000
Gates and operating machinery	40,000
Transportation line	45,000
Contingencies and superintendence	191,500
Amount	$2,400,000
Add water cushion wall	200,000
	$2,600,000

With sandstone faces throughout, and including water cushion wall, concrete core and independent spillway, the estimated cost of this dam would be $2,720,000.

Estimated Cost of Dam at Site No 2, Built to Height of 58 *Feet, but Susceptible of Extension to* 130 *Feet.*

One thousand four hundred acres of land, at $30..	$42,000
Four hundred and sixty acres of clearing, at $30..	9,200
Three acres of clearing and grubbing, at $100....	300
Bailing and draining whole work	50,000
Grouting in foundation	40,000
Seventy thousand cubic yards foundation excavation (earth), at 30 cents	21,000
Thirty-eight thousand cubic yards of foundation excavating (rock), at $1.....................	38,000
Two thousand cubic yards granite masonry, at $20..	40,000
Forty-five thousand cubic yards concrete, at $5.50..	247,500
One hundred and thirty-three thousand cubic yards concrete, at $4	532,000
Twenty thousand cubic yards concrete, at $3....	60,000
Ten thousand cubic yards clay puddle, at $1.....	10,000
Two hundred and forty thousand feet B. M. of oak timber in work, at $35.....................	8,400

Temporary gate-house building	$8,000
Gates and operating machinery	35,000
Transportation line	45,000
Contingencies and superintendence	173,600
Amount	$1,360,000
Add water-cushion wall	200,000
	$1,560,000

With sandstone faces throughout, and with concrete core, and including water-cushion wall, the estimated cost of this dam would be $1,640,000.

Estimated Cost of Completing a Dam at Site No. 2, *Built Originally to Height of* 58 *Feet, but Susceptible of Extension to Height of* 130 *Feet: Cost of Completing Between* 58 *Feet and* 130 *Feet.*

One thousand acres of land, at $30	$30,000
Four hundred acres of clearing, at $20	8,000
Changing highway at St. Helena	7,500
Five thousand cubic yards foundation excavation (earth), at 30 cents	1,500
Seven thousand cubic yards foundation excavation (rock), at $1	7,000
Thirty thousand cubic yards concrete, at $5.50	165,000
Seventy-two thousand cubic yards concrete, at $4 ...	288,000
Twenty thousand cubic yards concrete, at $3	60,000
One hundred and fifty thousand cubic yards earth excavation in spillway, at 18 cents	27,000
Four hundred and twenty-five thousand cubic yards rock excavation in spillway, at 70 cents........	297,500
Permanent gate-house building	20,000
Additions to machinery	10,000
Contingencies and superintendence	178,500
Amount	$1,100,000

With sandstone faces throughout, and with concrete core and independent spillway, the estimated cost of this dam would be $1,150,000.

Estimated Cost of Concrete Dam at Site No. 2, 58 Feet in Height.

One thousand four hundred acres of land, at $30	$42,000
Four hundred and sixty acres of clearing, at $20	9,200
Bailing and draining whole work	50,000
Grouting in foundation	25,000
Forty-two thousand cubic yards foundation excavation (earth), at 30 cents	12,600
Fifty-five thousand cubic yards foundation excavation (rock), at $1	55,000
Six thousand cubic yards granite masonry, at $20 ..	120,000
Seventeen thousand cubic yards concrete, at $5.50..	93,500
Fifty-three thousand cubic yards concrete, at $4	212,000
Eighteen thousand cubic yards concrete, at $3	54,000
Two hundred and fifty cubic yards coping, at $40 ...	10,000
Four hundred and eighty cubic yards coping, at $20..	9,600
Six thousand cubic yards clay puddle, at $1	6,000
Three thousand cubic yards riprap, at $4........	12,000
Gate-house building	12,000
Gate and operating machinery	25,000
Transportation line	45,000
Contingencies and superintendence	117,100
Amount	$910,000

With sandstone faces throughout, except for the spillway, where granite is provided, and with concrete core, the estimated cost of this dam would be $940,000.

In regard to the foregoing estimates it may be remarked that if instead of the granite facing for spillway it should be deemed safe to use a 1 to 1 beton, a still further reduction of cost of 130 foot dam at Site No. 1 of about $200,000 could be made, with proportionate reductions in cost of all the other dams, for which, in the estimates now submitted, granite-faced spillways have been provided.

An estimate for a 100-foot dam at Site No. 1 has also been prepared as given in detail on page 80. Comparison with the other estimates indicates that the cost of a dam of this height

at Site No. 2 would not differ greatly from the cost at Site No. 1. In either case it will be necessary in a dam of this height, to provide for passing the flood flows over the front, hence the general form of section, applicable to Site No. 1 and given in the preliminary report would be used.

In regard to the stepping of the spillways, it may be stated that further study indicates that for the large flood flows to be provided for in the case under consideration, it is doubtful if the stepping, as shown on the general sections of dams, applicable to Site No. 1, accompanying the preliminary report would be of any particular advantage, and it is consequently deemed better, all things considered, to use smaller blocks of granite than were estimated in the preliminary estimates, and set them with the beds at right angles to the curve of the front of the dam, at the same time dispensing with an expensive system of doweling, which was included in the original estimates. These several modifications of plan are considered sufficient to justify a reduction of the estimated price of the granite masonry from $30 per cubic yard to $20, a change which of itself reduces the estimated cost of this portion of the work about $175,000.

Again it may be pointed out that the success of a work of this magnitude will depend upon the care and intelligence of the superintendence, and all the suggestions and conclusions of this report are presented on the supposition that every part of the work receives such superintendence.

Moreover, it should be understood that while the estimates herewith submitted are believed to be amply sufficient to fully complete the work in first-class manner throughout, such result can only be attained in practice by the making of such administrative arrangements as will permit of the work going on continually from year to year with the same contractor and under the same general arrangements from beginning to end. It would appear desirable therefore to so draw the enabling act as to permit of the execution of a contract for the whole work at the original letting, rather than to rely on new contracts after each annual appropriation, as would be necessary under existing laws. So expensive a plant is required that a change of contractor from year to

year, or even the possibility of such a change, would tend to greatly increase the final cost of the work. It would, of course, be possible for the State itself to furnish the plant complete at the beginning, but this policy would be undesirable, as leading to vexatious questions in regard to maintenance and renewals not only on general principles but because of the possibility of partial or complete destruction of any part of the plant located in the river bed by floods. It will be better in every way to so arrange the contract as to permit of full assumption of all the responsibility for the necessary working plant by the contractor. As an alternative proposition, which would obviate this particular class of difficulties, the work could be constructed by day's work by the State, but this again would inevitably lead to an excess of cost over what can be attained by a well-devised contract, properly supervised.

The completion of a dam 130 feet high would require, as stated in the preliminary report, about five years time.

The time at my disposal has not permitted of any further consideration of transportation questions than that given in the preliminary report.

We come now to a discussion of the rainfall of the Genesee valley in its relation to the ordinary and flood flow of the stream. As the basis of any such discussion, Table No. 7, wherein is embodied the monthly means derived from all the records of rainfall observations that can be obtained, has been compiled. An inspection of this table will show that the rainfall year has been taken as beginning in December. The reasons for this will appear from the following general discussion, for which I am mostly indebted for the suggestion to an exceedingly valuable paper by Mr. C. C. Vermule, on Water Supply and Water Power, which appeared as a serial in the annual reports of the New Jersey Geological Survey for the years 1890, 1891, 1892.

As the basis of a storage project, we need to know (1) the minimum flow of a stream and the mean period of its continuance from year to year; (2) the maximum rate of flow during floods; and (3) the proportion of the rainfall which runs off in a year of minimum flow, together with the distribution of the same. Provided

we have sufficiently extended rainfall records, in conjunction with synchronous gagings of the flow of a stream, all these elements are at once easily known. Or gagings of a stream alone will give (1) and (2). If, however, the rainfall records are sufficiently extended we may arrive at an approximate knowledge of the elements of the problem by means of a comparative study of the rainfall and the results of gagings on other streams where the conditions are known.

The total rainfall upon a given drainage area is disposed of in the following ways:

(1.) A portion is evaporated directly by the sun.

(2.) Another portion is taken up by plant growth and largely transpired as vapor.

(3.) A third portion, large in winter and spring, but very small in summer, flows off the surface directly into the stream, forming ordinary surface or flood flows.

(4.) A final portion sinks into the ground, to replenish the great reservoir of ground water, from which plants are fed and stream flows maintained during periods when the rainfall is less, as it frequently is for months, than the combined demands of evaporation, plant growth and stream flow.

In regard to direct evaporation, so far as water surfaces are concerned, we have tolerably complete information, as derived from the elaborate experiments of Mr. Fitzgerald, at Boston, and many others. In the case of the upper Genesee river, with only one small lake (Silver lake) the proportion of water surface to total surface is so small that evaporation from water surfaces may be neglected. The data for estimating evaporation from the ground and the amount of water taken by various crops are much less extensive than that for water surfaces. The following, from Risler, gives the best available information as to daily consumption of water by various crops and two classes of forest trees:

	Inches.
Meadow grass requires from	0.134 to 0.267
Oats require from	0.140 to 0.193
Indian corn requires from	0.110 to 0.157
Clover requires from	0.140 to ....
Vineyards require from	0.035 to 0.031

	Inches.
Wheat requires from	0.106 to 0.110
Rye requires from	0.091 to .....
Oak trees require from	0.038 to 0.035
Potatoes require from	0.038 to 0.055
Fir trees require from	0.020 to 0.043

Applying these figures and we learn that our ordinary farm crops may take up from twelve to fifteen inches of water over the whole area cropped during the growing period. Forests, in the same way, may take up, in their growing period, from April to August, inclusive, from four to five inches, while cleared areas which are uncultivated, probably take up from seven to eight inches.

Forests then not only use less water than cultivated areas but they further tend to increase the summer flow of streams by holding back the water in accumulations of leaves and mosses until it can be gradually absorbed into the ground. Hence the importance of a large forest area as a conservator of stream flow on any given water shed. A drainage area entirely covered with forest may yield nearly double the flow during the growing season that will be obtained from an area either entirely or nearly entirely in cultivation. Independent of the drainage of swamps and low lands generally, we derive from these figures additional reasons why the summer flow of our streams, now, is smaller than formerly.

On cultivated areas the quality of the leading crop will further materially influence the run-off. Thus, an Illinois prarie, where Indian corn may occupy 50 to 60 per cent of the total area, will give a very different summer flow from one similarly situated, where crops demanding less moisture than Indian corn are raised.

As regards the present timber area of the upper Genesee watershed, it has probably been reduced somewhat in the fourteen years since 1880. The figures of the 1890 census are, however, not yet available, and those of 1880, are, accordingly, used as the best at hand. Because of the probable reduction of forest area since 1880, we may properly increase somewhat our estimate of

unimproved	321
odland and forest	28
Miscellaneous unimproved	39

From what has preceded we derive the following estimate average amount of water taken up by crops, etc., in the

less. Comparative gagings have shown that in the years wh[illegible] rainfall is about equal to the demands of vegetation, etc., the ru[illegible] off of streams is nearly constant at one and one-half inches on the whole drainage area. This amount is supplied almost entirely from the ground water stored during the previous storage period.

In years when the rainfall is less than these demands, the vegetation will draw to some extent on the ground water supply.

In the case of the upper Genesee the estimates of demands for plant growth clearly show an excess over the rainfall for average years. Hence it will not be safe to estimate the run-off at more than one inch over the whole area in the year of minimum flow.

September, October and November are the replenishing period. Nearly every demand for vegetation ceases by September first, while after October first the rapid fall in temperature tends to soon reduce evaporation to a very low quantity. The rainfall of this period goes largely to replenish the depleted ground water, and it is only after the ground water has reached its usual level that large run-offs occur; though on this point it may be remarked that the character of the rainfall, whether rapid or slow, will materially influence the quantity of the run-off in both the growing season and the replenishing period. Slow, drizzling rains in the growing season show absolutely no effect on the streams, while in the replenishing period, until after the ground water has reached its usual level, their effect is also very slight. A number of elegant illustrations of this general principle appear on the diagrams of flow of the Genesee river at Mt. Morris and Rochester, herewith submitted, and which are so clearly defined thereon as to render extended description unnecessary.

Applying the data derived from other gagings, and it is considered unsafe to estimate the run-off of this period for the minimum year at more than nine-tenths of an inch.

Referring to column 21 of Table No. 7, where the assumed safe amounts collectible in the year of minimum rainfall are carried out, and we find that the total amount collectible from the upper Genesee area, in the year of minimum rainfall, may be placed at 10.60 inches over the whole area.

Of all the rainfall records included in columns (1) to (18), inclusive, of Table No. 7, that at Rochester from 1829 to 1877, a period of about 45 years, is the longest. This record shows, in common with a number of the others, that the rainfall of the growing

and replenishing periods is a little over nine inches, and while the mean annual rainfall of the upper Genesee is about five inches greater than that of the lower, a study of the record shows that the excess is mostly in the storage period. At Rochester, where the minimum annual rainfall is as low as 20 inches, it is doubtful if anything like 10.60 inches could be collected in the minimum year. Probably 8.50 inches would be a safer estimate there. The long Rochester record, however, by reason of agreeing with the records of the upper valley, for the growing and replenishing periods, seems to enforce the reasonableness of the conservative estimate of run-off for these two periods which has been made.

It may be noted, however, that severe storms in the growing and replenishing periods may, at times, add something to the flow of a stream over and above that furnished by the ground water. In order to show the possible value of such accessions the greatest precipitation in twenty-four hours in each month, so far as available, has been included in Table No. 7. In the storage period, when the ground is frozen and covered with snow and ice, this part of the record is also of value as indicating the possible maximum flood of that period. This latter point will be touched upon further on. The effect of even severe storms in the growing period is comparatively slight, especially after the ground water has become depleted, as may be sufficiently illustrated on reference to the diagrams. But as soon as the ground water has reached its high level the effect of even slight storms is very marked.

Without going further into the detail, as a summation of the whole matter, it may be stated that the minimum flow of the upper Genesee may be taken at 10.60 inches for the whole year, with 8.70 inches in the storage period from December to May, inclusive, and the balance in the months from June to November, inclusive. For reasons in detail, other than those already given, reference is made to Mr. Vermule's discussion in the New Jersey geological reports, as already stated. As to the total amounts realized from the collection of different depths over the drain-

age area, reference may be made to the tabulated statement accompanying Mr. Kibbe's report of 1890.

If we consider the Genesee river as a whole we find that very different conditions govern. Between Rochester and Mount Morris and between Mount Morris and Dansville, in the broad valley of the Canesaraga creek there are extensive flats, amounting for the whole to perhaps 80 square miles. The drainage area at Rochester is 2,425 square miles as against 1,060 square miles at Mount Morris. The portion of the drainage area below Mount Morris also contains Honeoye, Canadice, Hemlock and Conesus lakes, which altogether provide a large volume of surface storage, while above Mount Morris there are few flats and only one small lake (Silver lake). The gagings made by Mr. Kibbie in 1890, as well as the gagings made since last August by the present writer, abundantly show that the upper section has a rapid run-off and is subject to sudden and excessive flood flows. These flood flows are received in the extensive flats below Mount Morris, where they are partially retained and gradually delivered to the extreme lower river. On inspecting the diagram, showing the relation of stream flow at Mount Morris and Rochester to rainfall and temperature, it is seen that the flood flows at Mount Morris are invariably as great as at Rochester, although the dry weather flow at Rochester is, proportionately to the drainage area, much greater than at Mount Morris. The flats then act to decrease the flood flow at Rochester and to increase the dry weather flow there. At Mount Morris we may expect flood flows of from 25,000 to 30,000 cubic feet per second nearly every year, while at Rochester 30,000 cubic feet per second is quite rare, even the great flood of 1865, probably did not materially exceed 35,000 cubic feet per second. About 30,000 cubic feet at Rochester gives a full river, and anything much beyond that figure will produce a disastrous flood. The flats then act to decrease in a very marked degree the violence of the spring freshet at Rochester. With the river in its natural state, and with the same character of drainage area throughout its whole course, that we find to exist above Mt. Morris, what is now the chief busi-

ness portion of the city of Rochester would certainly be entirely submerged nearly every year.

This immunity of the city of Rochester is, however, purchased at the expense of the 80 square miles of flats which annually act as an immense storage reservoir for the spring floods of the upper river.

From an economic point of view one marked effect of the annual inundation is to largely prevent the use of these flats for any agricultural purpose other than grazing. If they can be certainly relieved of the burden of that portion of the annual overflow which occurs in May, they will immediately become the most fertile agricultural lands in the State, and their value will be doubled. It is in line with the policy of all civilized governments to establish works for river conservancy wherever results are to be gained such as these, and the precedent of similar works by other governments is in view of the benefits to be derived by the commonwealth, in the way of increased valuation of property, the strongest possible argument that can be urged in favor of the Genesee river storage. The construction of the proposed dam to the height of 130 feet will so far control the flood flow of the stream as to almost entirely relieve the Genesee valley between Rochester, Mt. Morris and Dansville of the burden of that portion of the annual overflow which now tends to greatly decrease the value of these lands for any agricultural use other than grazing.

The question may be asked, whether the annual inundation is not really a benefit rather than an injury, by reason of carrying a large amount of valuable silt fertilizing material over the entire submerged area, as in the case of the river Nile and other irrigating streams. The answer is that, by reason of a heavy May rainfall, occurring at a time when the ground water is high and before vegetation has become active, there is likely to be an overflow just at the planting season, which effectually prevents the putting in of crops. Frequently, too, the May overflow extends over into the early days of June. On examining the diagram of river flow at Rochester, contributed to the survey by J. Y. McClintock, C. E., city surveyor of Rochester, it is seen that in 1893 the May overflow was at its extreme height on the

seventh, when the discharge at Rochester was at the rate of over 14,500 cubic feet per second; and on May twentieth the mean discharge at Rochester was 12,900 cubic feet per second. Flood discharges of these amounts are sufficient to render farming operations impossible on a considerable portion of the flat area. On June 2, 1889, the discharge at Rochester was at least 20,000 cubic feet per second, and from personal observations by the present writer on that day it is known that nearly the whole flat area of the valley was flooded. The answer to the hypothetical question as to the value of the annual overflow is, therefore, that in the case of the Genesee valley, the May overflow comes at such a time as to do only injury, without any opportunity to realize what would be, if the inundation came only in March or April, a great benefit.

The cash value then of so regulating the flow of the river as to do away with the May overflow, a result easily accomplished, can be estimated as an average of 80 square miles, at, say $40 per acre, or the increased valuation of the whole area would be about $2,050,000.

Moreover, the flats above Rochester are a further benefit to the lower river by reason of an immense storage of ground water therein, which, as the flood level subsides, gradually runs out with the result of greatly decreasing the period of extreme low water.

Again, in case of excessively heavy rains, in the middle of the summer, from the effect of which the river channel is temporarily, partially or wholly filled, such an amount of water is stored in these flats as to keep the river comparatively well up during the fall.

This actually happened in the season of 1893, when on August 29, there occurred a rainfall of nearly three inches over the whole drainage area in a period of about 12 hours, which produced a flood flow of 5,800 cubic feet per second at Mount Morris, and 4,800 cubic feet at Rochester; an amount of water sufficient to partly fill the channel between these two places, but without any overflow of the adjoining flats. Previous to this heavy rainfall, the mean flow at Rochester had been for a month about 460

cubic feet per second. At Mount Morris it had not averaged, for the same period, more than 125 cubic feet per second. The effect of this rain on the ground water of the flats, is strikingly shows by comparison of the two flows on the Mount Morris and Rochester diagram, where it will be seen that on September 3, the flow at Mount Morris, was again down to 200 cubic feet per second, and remained below that figure, except for slight rises due to rainfall on September 7 and 8, and September 15 and 18, until October 15, when the flow rose to a little over 2,000 cubic feet per second. At Rochester, on the other hand, the effect of the heavy rainfall of August 29, was to so far replenish the depleted ground water of the flats as, with the exception of a few days in the early part of October, when the flow dropped to about 800 cubic feet per second, to keep the flow up to about 1,000 cubic feet per second, for the balance of the year.

In order to further illustrate the great storage value of the flats, we may note that the drainage area at Rochester is 2.3 times that at Mount Morris; hence, for proportionate yields the flow at Rochester should be 2.3 times that at Mount Morris. From the diagrams we learn, however, that during August, 1893, at a time of extreme dry weather, the flow at Rochester was 3.7 times that at Mount Morris, and after the extreme storm of August 29, which replenished the ground water of the flats, the flow at Rochester, during the entire replenishing period (September, October and November), was more than five times that at Mount Morris.

A knowledge of this constant accession of large quantities of water from the flats leads to another conclusion of great practical importance, namely, that we may expect to realize, at Rochester, the full value of all the water added from the storage at Mount Morris; that is, an addition of, say, 700 cubic feet per second at Mount Morris, in time of low water, will be likely to increase the flow at Rochester 700 cubic feet per second more than it would have been without such addition.

In order to show more strikingly the value of the flats for such storage, we will now compute the amount stored and held back therein.

Referring to Rafter and Baker's Sewage Disposal in the United States, page 165, we find a tabulated statement of the per cent of empty space in a number of soils as follows:

	Per cent.
In Illinois prairie soil, the voids are	55.2
In East Winsdor, Connecticut, clay soil, the voids are...	48.3
In coarse river sand, the voids are from .... 38.4 to	41.0
In subsoils, the voids are from .... 34.6 to	42.6
In blowing sands, the voids are	44.7

From these figures we learn that an estimate of 33 per cent of void space in the soils of the flats would be very conservative. The mean low water surface of the river channel is mostly from 15 to 20 feet below the surface of the flats. We will also assume that the water runs out of the upper 5 or 6 feet quickly, but that it is retained and delivered slowly from the balance. We have then 33 per cent of say 12.0 feet or 4.0 feet in depth over 80 square miles as the probable available ground water storage of the flats. For 80 square miles this amounts to (80 x 640 x 43,560 x 4) = 8,921,088,000 cubic feet. If there were any way to control this ground water storage of the flats, it would by itself furnish an outflow of 800 cubic feet per second for four months, or 130 days. The diagram herewith submitted, taken in conjunction with the preceding discussion, shows about what the effect of this ground water storage is in the average year. For instance, on referring to Mr. McClintock's diagram of flow at Rochester, it is learned that the effect of this storage in June and July of last year was very marked. From it we see that the rainfalls of these two months had almost no effect on the flow of the stream which must have been supported almost entirely from the ground water. From May 28 to July 24, the delivery of the stream was steadily downward.

During this period the rainfalls were all used up by the demands of growing vegetation, and the flow of the stream was that due to stored ground water only, except possibly a very slight effect from the rainfall on June 6. By July 24, what may be termed the high level rapid

run-off ground water of the flats was entirely exhausted, and from that time on the flow was merely due to the deeper seated ground water of the whole area, assisted, however, by the relatively more rapid delivery of the flats. It may be remarked that the surface storage of the lakes of the lower river system is usually about exhausted by July 24.

As to the propriety of including in this discussion the area of the Canesaraga flats it may be mentioned that high water is stated by the inhabitants to only occur there when the Genesee is full to overflowing and is therefore mostly the result of backwater from the Genesee. The drainage area of the Canesaraga creek is 259 square miles, and although the creek channel has for several miles only slight declivity, it probably has capacity enough to discharge the ordinary flood flows, provided the Genesee were kept within its banks.

It must not be overlooked, however, that in the absence of instrumental surveys anything said on this point is subject to modification.

As a final conclusion of this division of the discussion it may be said that the construction of a storage dam, 130 feet in height, in the manner and at the point proposed, would so far regulate the flood flow of the river as to prevent any disastrous overflow of either the flats or the exposed area in the city of Rochester.

With intelligent management the outflow would be so regulated as to run the river channel full, or nearly full (but without overflow of flats) up to about June 1. In this way danger of floods would be removed and the benefits of the ground water storage in the flats retained.

Again the storage dam would render possible the producing of an artificial overflow of the flats in April, which would give all the benefits of silt irrigation at a season of the year when there would be no injury to any one.

The storage dam would furnish means for controlling such an overflow, both as to depth of water over the flats and as to length of time it would be allowed to remain.

We will now discuss briefly the possible maximum flood flows of the river and the effect of the proposed storage reservoir in

mitigating their severity. The data for this portion of the discussion is scanty, that directly applying being confined to Mr. Kibbe's gaging of 1890, as given on a diagram accompanying his report of that year, and the gagings of last year made at Mt. Morris and at Rochester, the results of which are included on the two accompanying diagrams already discussed. As stated in the preliminary report, a determination of the maximum floods has a practical bearing on the length of spillway to be provided for the storage dam, and while we have only cursory knowledge of their magnitude, as derived from direct observation on the stream itself, we may learn something by considering the flows of other streams of similar topography and the same or nearly the same drainage area. The following are the only American streams of approximately the same drainage area of which fairly complete statements of extreme flood flows are at hand:

(1) The Passaic river, in New Jersey, with an area of watershed at Little Falls of 773 square miles. The highest recorded flood flow is that of September, 1882, at which time 19,105 cubic feet per second flowed. This would be at the rate of 24.7 cubic feet per second per square mile, which quantity applied to the upper Genesee drainage area of 1,060 square miles, gives 26,182 cubic feet per second. The Passaic, however, can not be taken as a safe guide in this particular, because it has, like the lower Genesee, a considerable area of flat and surface storage. As indicating the possibilities of extreme floods at Rochester, we find on applying a maximum flow of 24.7 cubic feet per second per square mile to the lower Genesee area of 2,425 square miles, a possible flood there of 59,898 cubic feet per second. Such a flood would sweep through a large area of the city, and, if long continued, would do damage amounting to hundreds of thousands of dollars. Inasmuch as the State has paid extensive damages at Rochester on account of the flood of 1865, such figures are suggestive as to the desirability of reasonable expenditure either to prevent a recurrence of the flood of 1865 or of the much larger one which a comparison of figures actually obtained from the Passaic shows to be among the possibilities.

(2) The Raritan river, in New Jersey, with a watershed above the point of gaging of 879 square miles. This stream has very

little storage anywhere on its watershed. The drainage area is mostly under high cultivation, only 13 per cent being in forest. From this fact its extreme flood flows are likely to be somewhat larger proportionately than those of the upper Genesee, with which in other particulars it is fairly comparable. There have been three great freshets on this stream during the present century, in 1810, 1865 and 1882. The following are some of the particulars of that of 1882: .

On September 22, at 3 p. m., the flow was 7,000 cubic feet per second.

On September 23, at 3 p. m., the flow was 35,000 cubic feet per second.

On September 24, at 5 p. m., the flow was 52,000 cubic feet per second.

On September 25, at 7 a. m., the flow was 7,000 cubic feet per second.

Thus giving a total discharge in 64 hours of 6,489,000,000 cubic feet or 3.36 inches on the watershed.

The maximum on September 24 was 59.2 cubic feet per second per square mile, which figure, when applied to the upper Genesee, gives 62,752 cubic feet per second from the whole area.

(3) We come now to a case nearer our own, namely that of the great flood in the Chemung river at Elmira, in 1889, at which time, according to the thorough study of Mr. Collingwood, this stream gave a maximum flow from a drainage area of 2,055 square miles of 138,000 cubic feet per second, equivalent to 67.1 cubic feet per second per square mile, which quantity applied to the upper Genesee would give a possible maximum discharge of 71,126 cubic feet per second.

The Chemung drainage area joins the Genesee area on the east and an inspection of the State meteorological bulletin maps shows that the rainfall for the Chemung area must be about the same as for the upper Genesee. We may, therefore, consider the 1889 flood on that river a little in detail, the more especially since it occurred in the period of general heavy rainfall during which the dam at Johnstown broke, and at which time the Genesee

river at Rochester discharged 20,000 cubic feet per second as noted on a previous page of this report.

In the vicinity of Elmira, the rainfalls which produced this flood were as follows: At Wellsboro, 36 miles southwesterly, the total precipitation was 9.8 inches, of which 7.45 inches fell after 9 p. m., of May 31, and before 7 a. m., of June 1.

At South Canisteo, about 45 miles west from Elmira and only a few miles east of the dividing ridge between Chemung and Genesee drainage, the total rainfall was 6.25 inches, of which 4.6 inches fell in three hours. Two miles west of South Canisteo 6.0 inches fell in the same time.

At a number of other points in the vicinity, rainfalls of from 6.0 to 8.0 inches in not more than 10 to 15 hours were observed.

The Chemung river is formed by the junction, a short distance above Elmira of the Tioga, Canisteo and Cohocton rivers.

The Tioga is a rapid stream heading near Blossburg in Tioga county, Pennsylvania, and descends to its junction with the other streams, at rates varying from 80 feet per mile at its head to 11 feet per mile at its mouth.

The Canisteo, of which the drainage area adjoins the Genesee on the west, has slopes in its lower reaches of about 5.5 feet per mile. The Cohocton is also a stream of comparatively low slope, while the Chemung itself, below the point of junction of the several streams, has, for some distance, a slope of 5.9 feet per mile, although through the city of Elmira, the slope is only 3.5 per mile.

We have then the Tioga, a rapid stream of 750 square miles drainage area; the Canisteo much less rapid, with a drainage area of 780 square miles; the Cohocton, also, only moderately rapid, with an area of 425 square miles, and the Chemung directly above Elmira, draining about 100 square miles, making a total of 2,055 square miles, as already noted.

The net results of a rainfall at the end of May, when the ground water was high, of from 6.0 to 10.0 inches over an entire area, varying in composition in the manner indicated, was a flood of such unprecedented magnitude that its like may probably not occur again in a century, and the practical question is whether the spillway of the Genesee storage dam should be designed with

reference to the possible extreme. Taking into account the character of the rainfall — that is, its distribution and the tendency to heavy falls in 24 hours, the character of the drainage area, the data derived from studying the flood flows of other streams of which the drainage areas are known, and some of which have been cited in the foregoing, and the fact that the present dam at Mount Morris, with a spillway 337 feet in length and 10 feet from crest of spillway to top of parapet wall, has never yet, in 50 years service, been taxed beyond its capacity to discharge, it has seemed to the present writer that the length of spillway of 400 feet, tentatively assumed for the purpose of the preliminary report, could be fairly settled upon as sufficient for any probable demands. In arriving at this conclusion it has been further assumed that, inasmuch as the extreme flood flows are of short duration, a maximum depth on spillway of 10 feet could be allowed. This gives for 400 feet length a discharge of about 41,000 cubic feet per second, equivalent to 38.8 cubic feet per second per square mile.

It may be further stated that before arriving at the foregoing conclusion, so far as the writer knows, all the American literature of stream flow in relation to rainfall has been examined. Its voluminousness, however, prevents more specific reference in this place.

As a final question we will consider in detail the effect of the storage provided by a dam 130 feet in height in preventing disastrous overflows in the broad valley below.

In the first place the storage provided by such a dam will be, as shown by Mr. Bailey's tabulation, accompanying his report of 1890, from 7,040,000,000 to 7,670,000,000 cubic feet, the exact quantity depending upon whether Site No. 1 or No. 2 is finally selected; 7,500,000,000 cubic feet would amount to nearly 3 inches over the whole drainage area.

On examining the records of greatest rainfalls in 24 hours, in columns (2), (6), (7), (8), (9), (10), (11), (14), (15) and (16) in Table No. 7, we find that we are likely to have two inches of precipitation in 24 hours during the months of December, January, February and March, at which season we may further expect to have

at times the ground frozen, and at the same time a considerable body of snow, which may likewise be melted by a heavy rainfall. We may assume the contribution from such source sufficient to make a run-off of 3 inches in 24 hours, or enough to completely fill the reservoir created by a dam 130 feet in height. If such a run-off occupied three days time it would be at the mean rate of about 29,000 cubic feet per second.

The management of the reservoir would ordinarily be such as to leave it empty at the end of January. If then the reservoir were to be completely filled during February or March by such an extreme inflow as we have just discussed, the natural course would be to gradually draw it well down through the sluices, leaving ample space for storage of the heavy flow of May. Working on these lines probably the lower Genesee would not go out of its natural channel more than once or twice in a century.

The most unfavorable case that can be assumed is that of the occurrence of an extreme run-off when the reservoir is full to the flow line. Even under such circumstances the reservoir will still act as a great mitigator of an extreme flood flow, as may be seen by inspecting Table No. 8, which has been prepared specially to illustrate the point in question. The following discussion will indicate the principle embodied in this table.

As already stated, the efficiency of the proposed storage reservoir as a flood moderator will depend upon the storage capacity in relation to the quantity of water flowing in from the drainage area. This capacity includes all storage space, whether above or below the crest of the overflow weir, which may be available at any time of heavy storm. Water is stored in the space above the crest only temporarily, but this space may still play an important part in reducing the maximum discharge below the reservoir, by extending the time within which the total surplus has to be passed down.

Inasmuch as extreme flood flows are of short duration, we may neglect the effect of evaporation, absorption and leakage, whence it becomes evident that the discharge by the overflow weir or sluices will be equal to the quantity received, less the quantity retained, whether temporarily or otherwise.

TABLE NO 8. — EFFECT OF FULL RESERVOIR IN MITIGATING EXTREME FLOODS.

h. above crest in feet.	Total depth in reservoir in feet.	Storage =C. in cu. ft.	Intermediate values of C.	Q at height h. cu.ft. per sec.	Qp= means values of Q cu.ft. per sec	Time t. in seconds.	Total time in seconds.	Outflow in each period in cu. ft.	Total outflow in cu. ft.	Total inflow in cu. ft.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
0	130.0	0		0		0	0	0	0	
			51,221,000		230					
0.5	130.5	51,221,000		459		1720	1720	395.700	395,700	
			51,297,000		899					
1.0	131.0	102,518,000		1340		1763	3483	1,583,800	1,979,500	
			51,374,000		1864					
1.5	131.5	153,892,000		2388		1836	5309	3.403,500	5,383,000	
			51,449,000		3033					
2.0	132.0	205,341,000		3677		1908	7217	5,784,400	11,167,000	
			51,526,000		4408					
2.5	132.5	256,767,000		5139		2018	9230	8,874,900	20,042,300	
			51,602,000		5947					
3.0	133.0	308,369,000		6755		2145	11375	12,757,700	32,800,000	
			51,678,000		7634					
3.5	133.5	360,047,000		8512		2311	13686	17,640,000	50,440,000	
			51,754,000		9456					
4.0	134.0	411,801,000		10400		2519	16205	23,822,000	74,262,000	
			51,830.000		11405					
4.5	134.5	463,631,000		12410		2787	18992	31,790,000	106,052,000	
			51,907,000		13470					
5.0	135.0	515,538,000		14530		3140	22132	42,298,000	148,350,000	
			51,983,000		15655					
5.5	135.5	567,521,000		16780		3634	25756	56,730,000	205,080,000	
			52,059,000		17943					
6.0	136.0	619,580.000		19106		4318	30074	77,478,000	282,558,000	
			52,135,000		20338					
6.5	136.5	671.715,000		21569		5396	35470	109,035,000	392,295,000	
			52,212,000		22823					
7.0	137.0	723,927,000		24076		7275	42745	166,085,000	558,380,000	
			52,287,000		25389					
7.5	137.5	776,214,000		26702		11340	54085	287,902,000	846,282,000	
			52,364,000		28059					
8.0	138.0	828,578,000		29416		26980	81065	756,972,000	1,603,204,000	2,431,782,000
			52,439,000		30816					
8.5	138.5	881,017,000		32216						
			52,516,000		33658					
9.0	139.0	933,533,000		35100						
			52,592,000		36583					
9.5	139.5	986,125,000		38065						
			52,668,000		39588					
10.0	140.0	1,038,793,000		41110						

We will assume that the water stands at the level of the crest at the instant when the inflow becomes equal to 30,000 cubic feet per second, and that the inflow remains constant at that figure for 24 hours, after which it gradually decreases. We desire to determine the length of time which will elapse before the outflow reaches 30,000 cubic feet per second, and the approximate time it will remain at about that figure. With the following notation:

h = any given height above the crest in linear feet and h_1, h_2, h_3, etc., successive equal heights.

c = storage capacity corresponding to h, and c_1, c_2, c_3, etc., successive capacities.

q = discharging capacity of the overflow weir in cubic feet per second, as determined by the formula $Q = 3.3 \sqrt{h^3} \times l$ for the given values of h, h_1, h_2, h_3, etc.

Q_p = the mean discharge in cubic feet per second for any given period, as for instance, $Q_p = \frac{Q_{h_2} + Q_{h_3}}{2}$ and

$$Q_{p_1} = \frac{Q_{h_2} + Q_{h_3}}{2}, \text{ etc.}$$

S = inflow from drainage area, taken in the present case at 30,000 cubic feet per second; and

t = the time in seconds in which the water will raise to any given value of h above crest.

Whence we have the formula,

$$t = \frac{c}{S - Q_p}$$

by which Table No. 8 has been computed.

On referring to Table No. 8 we learn:

(1) That, with water surface in reservoir at level of crest of overflow weir and a constant inflow of 30,000 cubic feet per second, it will be about 6.5 hours before the outflow will reach 15,000 cubic feet per second.

(2) That under the same conditions it will be about 24 hours before the outflow will reach approximately 30,000 cubic feet per second.

(3) Inasmuch as the original assumption was that the inflow should only be at the rate of 30,000 cubic feet per second for 24 hours and then gradually decrease, we may therefore say that the flow at rate of about 30,000 cubic feet per second would only be for say two or three hours, instead of at least 24, as it would have been without the assistance of the surface storage of the reservoir.

(4) The total inflow in 22.5 hours would be 2,431,782,000 cubic feet, of which 34 per cent of the whole would be stored during that time temporarily in the reservoir.

Other deductions can be made, but the foregoing are enough to show the great practical value of such a reservoir as a moderator of floods even when entirely filled at the beginning of the maximum flow.

In the same way if we assume the reservoir full and an inflow at the rate of 40,000 cubic feet per second, we learn on making the numerical computation that about 19 hours would elapse before the outflow would reach approximately that amount, in which time a depth of ten feet would be reached on the crest. The total inflow in 19 hours would be 2,904,735,000 cubic feet, of which 1,865,942,000 cubic feet would flow out and 1,038,793,000 cubic feet, or nearly 36 per cent of the whole, would be stored temporarily on the surface of the reservoir.

On referring to page 96, the statement will be found that flood discharges at Rochester, of from about 13,000 to 14,500 cubic feet per second, and from these quantities up to 20,000 cubic feet per second, represent more or less flooding of the flats above Rochester. This statement must not be taken to mean that, when such flows take place at Rochester, the inflow to the flats is anything like as small as 15,000 to 20,000 cubic feet per second. Table No. 8, may serve to enforce the statement that the inflow to the flats from the whole tributary area may be, at times, as large as 100,000 cubic feet per second, and there still be no serious flood at Rochester.

Making a rapid resume of the whole matter, and we may say that the benefits to be derived from the construction of the proposed Genesee river storage, are:

(1) The furnishing of an adequate supply of water to the eastern section of the western division of the Erie canal, under any and all circumstances.

(2) A great increase in the permanent water power of the Genesee river at Mount Morris, Rochester and intermediate points.

(3) The protection of the Genesee flats and the city of Rochester from destructive floods.

If we compare the estimated cost of the proposed storage with the cost of other large storage projects, we find that the Genesee storage will compare very favorably with other large projects of this character thus far carried out, as, for instance:

(1) The Sweetwater masonry dam in California, where 784,080,000 cubic feet are stored, cost $938.70 per million cubic feet stored.

(2) The Hemmet Valley masonry dam in California, where 6,111,280,000 cubic feet are stored, cost $229.10 per million cubic feet stored.

(3) The Periar masonry dam in India, where 6,969,600,000 cubic feet are stored, cost $106.75 per million cubic feet stored.

(4) The Betwa masonry dam in India where 1,603,008,000 cubic feet are stored, cost $204.25 per million cubic feet stored.

Taking the total cost of the Genesee river storage dam, 130 feet in height, at $2,400,000, and the storage at 7,700,000,000 cubic feet, and we derive a cost per million cubic feet stored of $311.69.

On taking the total cost at $2,600,000, and the storage at 7,100,000,000 cubic feet, and we have a cost per million cubic feet stored of $366.20.

Respectfully submitted.

GEORGE W. RAFTER,
Engineer in Charge.

APPENDIX F.

REPORT

ON

MOVABLE BRIDGES AS USED IN EUROPE

WITH

SPECIAL REFERENCE TO THE BRIDGE OVER THE ERIE CANAL AT WEST MAIN STREET, ROCHESTER, AS WELL AS THE GENERAL APPLICATION OF SUCH BRIDGES TO CITY STREETS ALONG THE ENTIRE LINE OF THE ERIE CANAL.

APPENDIX F.

ROCHESTER, N. Y., *January* 15, 1895.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor, Albany, N. Y.:*

Dear Sir.— In accordance with your instructions of September 5, 1894, I have examined the various forms of movable bridges used in Europe, with reference to their applicability to the conditions obtaining at West Main street, in the city of Rochester, as well as to the conditions generally governing the use of such bridges along the line of the Erie canal, and have the honor to submit herewith my report relating to the same.

By act, chapter 652, Laws of 1894, an appropriation was made for the purpose of either repairing the lift-bridge constructed in 1889, at West Main street, in Rochester, or else to prepare plans for a new bridge at that place, the decision of just which to do being left by the terms of the act to the honorable State Engineer and Surveyor.

In view of this state of affairs, it seems proper, before approaching the main subject, to discuss briefly at this time the conditions governing the use of movable bridges along the line of the Erie canal. Especially is it desirable to consider fully the reasons for and against the use of such bridges, (1), because of the several bridges of that class heretofore constructed, some are likely to be renewed, on account of either unsatisfactory operation, or because the traffic of the streets whereon they are situated has increased so greatly as to render more extensive accommodations for street traffic imperative; and (2) because, in a number of cases where fixed bridges with steep, graded approaches were erected at the time of the original construction of the Erie canal, the growth of the towns has rendered the old

bridges with steep grades inapplicable, and some form of new construction more in line with the conditions existing at the present time is necessary.

In order to emphasize this statement, we may point out that when the Erie canal was opened, in 1823-1825, what are now the metropolitan cities of Buffalo, Rochester, Syracuse, Utica and Albany, were then small towns, with, at the best, but a few thousand inhabitants, while many large villages, such as Albion, Palmyra, Newark, Lyons, Little Falls and others had hardly come into existence.

Generally speaking, the canal was located either entirely outside the limits, or in the outskirts of the towns, as they existed at that date. The bridges originally erected along the entire line were mostly of a form suited only to country roads; the approaches were usually steep, in some cases as much as seven or eight feet to the 100.

After the completion of the canal, a great era of material prosperity began, during which the inland towns grew rapidly, many of them, as, for instance, Rochester, Syracuse and Utica, spreading out and stretching for long distances on both sides of the canal.

On the more important business streets of these cities, the original steep approaches were lengthened out, with grades of from four to five per 100, while, on back streets of little traffic, many of the original approaches remain practically unaltered to this date.

Again, as time went on there came a demand on the more important business streets that greater facilities be afforded to street traffic, which finally led to the construction of a number of swing and lift-bridges.

The first solution of the problem was by the use of swing bridges, placed on central piers. Such bridges are, however, very unsatisfactory to the boatmen by reason of being constructed with narrow water-ways at each side of a central pier, and their construction has been discontinued. Moreover, such bridges must necessarily be very narrow, as otherwise the

width of the central pier on which they stand becomes too great for the width of the canal; from whence it results, that, taking into account the present assumed necessity for wide bridges, those of the swing pattern may be considered inapplicable.

It may be remarked, in passing, that balanced swing-bridges, of the English pattern, can not be used in the majority of places where movable bridges are required, because of lack of space at the sides in which to locate and operate them; or, at any rate, their adoption would necessitate the acquiring of some land outside the line of the canal property; and usually the movable bridges are required in localities where the acquiring of such would be a source of large expense. Moreover such bridges when constructed of some width present special difficulties which would inevitably limit their use.

A further consideration of the problem finally led to the construction of a number of lift-bridges, the first of these having been erected about 16 years ago at Allen street in the city of Rochester.

The general plan followed at that time was a pair of parallel overhead girders standing on corner posts, with a counter-weighted bridge platform suspended therefrom; the operating mechanism being some form of hydraulic motor from which the power was transmitted to an overhead shaft with pulleys for counter-weighted cables, by means of a cable. A number of such bridges have been constructed at Rochester and at other points, and there is now a considerable demand for movable bridges of some sort in all of the large towns along the line of the Erie canal.

Having thus presented briefly the general history of movable bridges as applied to the Erie canal, we may now consider the specific case of West Main street at Rochester. This case is especially interesting because it illustrates some of the changes in the popular demand for movable bridges over the Erie canal in the large interior streets of the State, which have taken place in the last 20 years.

The situation at West Main street is rather peculiar. West Main street itself crosses the Erie canal at an angle of about

45 degrees, while near by Caledonia avenue crosses nearly at right angles. It thus becomes necessary to consider the bridging of these two streets together. The two original fixed overhead bridges were removed in 1875, the steep approaches cut down, and a single swing-bridge substituted, crossing the canal at right angles and so placed as to fairly accommodate the traffic of both West Main street and Caledonia avenue.

The single swing-bridge, however, was hardly satisfactory to the people of either streets, and finally the decided expression of such dissatisfaction led to the construction, a few years ago, of two lift-bridges of the type already described, on the lines originally occupied by the fixed bridges referred to as removed in 1875.

The several changes which have taken place at West Main street within the last 20 years serve to illustrate, saliently, how thoroughly the construction of public works is amenable to public opinion in the United States. The original fixed bridges at West Main street and Caledonia avenue were removed in obedience to such a demand in 1875. The single swing-bridge, which took the place of the fixed bridges, having, on trial, proved unsatisfactory to the street traffic, it was then removed, and the present lift-bridges substituted therefor; the fact that one of the new bridges, or rather the fact that the West Main street bridge last constructed is unsatisfactory in its mechanical appliances is in reality the reason for the preparation of this report.

It is no part of my intention to criticise in any way the design or construction of any of the structures of the class under discussion thus far used at West Main street, or at any other point on the Erie canal. It may, however, be very properly pointed out that some of these structures, at any rate, have been erected without due regard to all the attending circumstances. For such a condition of affairs the popular demand for immediate results must be considered as in some degree responsible. This has undoubtedly led to the hurried design in some cases of bridges for particular localities, without due regard to all the cir-

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cumstances which should be taken into account at such localities.

As regards the mechanical lift-bridges, they have, generally speaking, served the purpose thus far in the New York inland cities. But, as a general proposition, their necessary lack of symmetry condemns them for future use. If the American cities are ever to reach the high plane of finish and artistic adaptation of means to the desired end, which characterizes the European cities, our municipal engineers, and especially those charged with bridge design, must consider the artistic as well as the merely useful features of the case. The future growth of the towns, as well as the canal traffic, must also be taken into account.

Nothing impresses the visitor to the European cities more than the elegant appearance of the various classes of bridges. In many places where bridges are required over canals, large open spaces have been left, and the bridge, by effective architectural treatment, made the central point of attraction of the open space. In other cases, embankments and quays of the most expensive character have been constructed along streams passing through the towns, in order, largely, to give the full architectural value of the river bridges as a part of the effective adornment of the town.

It is the use of engineering skill of this high order, which has made the European cities so far superior in mere finish to our own; and it is the belief that an enlightened public opinion will demand the use of a similar class of skill in the future public works of this State, that leads to this brief discussion of the artistic side of the question, as opposed to the mere utilitarian, at this time.

As a general proposition, we may say, that nothing adorns a city more than fine bridges.

During my absence in Europe, the subject of movable bridges has been discussed at length by different citizens in the news-

papers of this city, and various remedies for the difficulties which exist here have been proposed. One of these remedies contemplates the lowering of th canal through the entire business portion of the city of Rochester, locking down into a lower level at both ends, the surplus water of the lockage to the lower level being disposed of by a deep channel constructed either independently, or connected with deep city sewers, now discharging below the brink of the upper Genesee falls. With an ample supply of water to the east of the proposed low level, the chief objection that could be urged against this plan would be the delay and annoyance to navigation caused by adding two new locks. But so long as the canal for a long distance east of Rochester must be fed from Lake Erie, this particular plan may be dismissed as on the whole not specially feasible, although is is recognized that if necessary a construction could be made which would obviate the difficulty of feeding from the west.

Senator C. R. Parsons has proposed to change the line of the canal to a new location, either wholly or in part outside of the city. This, also, is probably feasible, but involves so extensive surveys before one could discuss it in detail satisfactorily that I can do no more at present than to merely call attention to it as one of the remedies which has been proposed.

J. Y. McClintock, C. E., city engineer of Rochester, has proposed as a remedy for the difficulties at West Main street, the building of fixed overhead bridges with long flat approaches, the grades of which shall not exceed 3 to 3.5 per 100, and as this plan possesses the merit of being in line with nearly the universal practice in England and France, we may properly discuss it a little in detail. Before so doing, however, I will give a short account of my studies of movable bridges as applied to inland navigable canals in Europe.

The inland canals of England differ from our own in two respects: (1) They are all owned by private corporations, or public trusts; (2) they are operated throughout the entire year. By courtesy of James Forrest, Esq., secretary of the Institution of Civil Engineers of England, I was furnished with introduc-

tions to the managers of a number of the principal canals of England, as well as to the managers of the principal dock corporations of London, Liverpool, etc. These gentlemen are leading civil engineers, and all manifested great interest in my investigations; several of them expressed considerable surprise that, under any circumstances, we should think, for a moment, of cutting down and removing fixed bridges, with a view of substituting any form of mechanically operated bridge whatever. In dock practice where vessels with high masts require passage, a balanced swing-bridge has been used extensively abroad, and a number of bridges of that class, which have been in use over 50 years, and which are still doing their work satisfactorily, were seen about the different docks of London, where the experience with this class of bridge extends over more that 100 years. The opinion of the engineers of the London docks was quite decided, that taking into account expense of maintenance it would be cheaper to build in city streets, where it could be done, fixed bridges, with which the expense of maintenance must be, of necessity, when properly constructed, little or nothing.

The Grand Junction canal, of which Hubert Thomas, Esq., is general manager, is the longest canal in England, all under one management, the length being somewhat over 200 miles. This canal, with certain others, connects London with Birmingham, and with its various ramifications passes through some of the most populous portions of England. Most of the bridges are fixed, with grade of approaches, from one in 20 to one in 30, say an average of one in 25.

There are, however, a few movable bridges along the line of this canal, of the swing-bridge pattern.

The Aire and Calder canal may also be mentioned as one of the more extensive inland navigations in England.

By courtesy of W. H. Bartholomew, Esq., general manager of the Aire and Calder canal, I was furnished with a written statement relative to the bridges on this canal, from which it appears that here, as elsewhere in England, the bridges are mostly fixed, although there are a few swing-bridges, and one bridge of the

bascule pattern, to be discussed at length further on in this report.

On the Liverpool and Leeds canal, which passes through the thickly-populated manufacturing districts of Lancashire and Yorkshire, the bridges are nearly all of the fixed type.

DeCourcy Meade, Esq., city engineer of Manchester, stated that in Manchester the traffic on both the canals and the streets was so great as to render any interruption of either impracticable. Bridges over canals in that vicinity are, therefore, perforce, of necessity of the fixed pattern. So far has this feeling extended, that, even on the Manchester ship canal, two highways have been carried, by heavy embankments and elaborate bridges, far enough above the line of the canal to leave a clear headway of 75 feet, which is the opening required for the passage of large ocean steamships. Plate VII. illustrates one of the bridges of this character over the Manchester ship canal. In cases where the conditions were such along the line of the Manchester ship canal as not to admit of elevated fixed bridges, swing-bridges, operated by hydraulic machinery, have been used. As a matter of interest, it may be stated that the Bridgewater canal, an ordinary inland canal, has been carried across the line of the Manchester ship canal by means of an hydraulicly-operated swing-bridge, arranged with gates at the ends, which permit the opening of the bridge, whenever vessels are required to pass through the ship canal, without the loss of any considerable amount of water from the aqueduct of the inland canal.

By courtesy of Sir E. Leader Williams, chief engineer, I was given facilities for witnessing the operation of this aqueduct bridge, which is known as the Barton aqueduct. Its perfect mechanism may serve as a model for similar structures throughout the world. Before finally deciding to build the Barton aqueduct in the form of a swing-bridge, various plans were thoroughly studied by the canal engineers. Among others the plan of carrying the canal in a trough, which could be lifted by hydraulic rams to such a height as would permit vessels to sail underneath, was considered, but finally the plan of a swinging

caisson was adopted as being, on a whole, the most desirable. Water is so scarce along the line of the Bridgewater canal, that locking down into the Manchester ship canal on one side, and locking up again on the other, was precluded, because of the considerable waste of water which would ensue; indeed, it was considered necessary, that, whatever the arrangement adopted, the loss of water must be reduced to practically nothing. On this account the swinging tank, with double gates at the ends, was adopted, as being the most desirable. This tank, with its supporting girders, is 234 feet long and 22 feet wide from center to center of the booms. The tank itself is 19 feet wide and seven feet deep, but the actual water depth is only six feet. The towing path is raised nine feet above the water level, and is bracketed out over the tank to reduce the width as much as possible.

The bridge is always swung with the trough full of water, the weight of the moving portion with its liquid load being about 1,600 tons. In order to secure a perfectly steady motion and to avoid any rocking which might cause oscillation of the water in the trough, the center pivot was formed as a hydraulic ram, four feet nine inches in diameter, and two feet three inches in depth, and, before swinging, half of the load is taken off the rollers and borne by the ram. Whenever it is necessary to swing the bridge in order to allow the passage of vessels in the ship canal, water-tight, hydraulicly-operated, steel gates are closed at each end of the tank, and at each end of the fixed shore approaches. These gates, when closed, are parallel to each other, with only a slight space between, which is emptied by a displacement box and outlet valve. In this way the pressure is brought to bear on one face of each gate and a tight joint secured. In the same way, when it is desired to open the end gates, water is admitted between and equilibrium restored.

Probably, however, the most interesting point about the Barton aqueduct is the means which have been devised for securing the water-tight joint between the fixed ends and the ends of the cassion, and, inasmuch as the means adopted, while very simple,

are still unique, we may properly take space to describe them a little in detail. The first plan proposed was to cause the ends of the tank to batter slightly from the vertical, and to cut the upper edge of the shore ends in the same degree. It was further proposed to face the parallel portions with India rubber, and, by constructing the whole of the moving portion of the bridge on the head of a hydraulic ram, in the manner already referred to, it was hoped to secure a tight joint by jamming the tank upward against the shore ends. This plan was, however, abandoned, owing to the probable difficulty of securing an exactly-balanced upward motion, as well as for other obvious reasons not necessary to go into here, and finally a plan almost exactly the opposite was adopted. As actually constructed, the ends of the swinging tank do not touch the shore end by about 12 inches, and the sides of both tank and shore ends are cut away so as to batter from each other outward. This gives a section which, viewed from the side, shows a V-shaped gap between the two parts at each end. This space is filled with a taper collar weighing 12 tons, and conforming to the cross section of the canal, which is faced with India rubber and raised or lowered by means of four hydraulic presses, two acting on the sides and two underneath. When this collar is lowered down on its taper bearing, it is evident that a tight joint is secured, and when the rams lift the collar, enough clearance is given to permit the bridge to swing clear. As further assisting the clearance, the ends of the tank are cut slightly on the cant, and are not at right angles to the center line of the bridge. With this arrangement, it is clear that the bridge can be swung only one way.

At Liverpool, E. A. Cottrell, Esq., chief engineer of the Overhead railway, afforded me facilities for seeing a number of interesting bridges on the line of that road. The Liverpool Overhead railway extends for several miles along the water front of the river Mersey, and just at the back of the property of the Dock estates. There are a number of points where it is necessary to have clear openings through the railway, either

for the passage of high freights to the docks, or for the passage of boats to canals or slips which extend back of the Overhead railway.

One of these bridges, while embodying nothing specially applicable to conditions now existing on the Erie canal, is still of considerable interest because of illustrating the possibility of applying complex mechanism to the structures of the kind now under discussion, provided the work of construction is properly carried out. The bridge in question is that at the Stanley docks, where the railway crosses a dock slip 50 feet in width, with an ordinary wagon road, with railway tracks therein, directly underneath the railway. At this point there was an ordinary swing bridge for the accommodation of the roadway, before the construction of the Overhead railway; and owing to the constant traffic of vessels through the dock slip, and of ordinary vehicles on the wagon road, it was impossible to interrupt traffic at this point except for very brief intervals. The plan which was adopted is described as follows, in a paper on the Liverpool Overhead railway, which appears in Vol. CXVII, of the Proceedings of the Institution of Civil Engineers, where also may be found illustrations of the bridge:

"On the level of the dock-rails a double line of railway is provided for dock traffic, and on the upper level a double line of railway for the Overhead railway, thus constituting a double-deck railway bridge. The lower level is arranged with bascule leaves. so that barges and small crafts can pass through without the necessity of swinging the bridge and interrupting the railway. The bridge is actuated by hydraulic power obtained from the Hydraulic Power Company's mains. To enable the bridge to be completely opened, the following movements have to be made. The bridge is, in its normal position, a fixed structure, resting on bearing blocks at the tail end, and upon two legs at the front of each abutment. The first act is to lift very slightly the tail end of each half so as to allow the bearing blocks to be withdrawn; this done, the tail end is lowered until the rollers rest on the tail-race; and in doing this, the pivot of the bridge comes in contact with its cup-bearings, canting the girders upward at

the nose-end and lifting the legs from their supports. When this operation is completed, each half of the bridge rests on its pivot and on the rollers on the tail-race, and is then ready for swinging."

At three points on the line of the Liverpool Overhead railway, bascule bridges of a very simple character, with openings of about 35 feet each, are provided for the purpose of permitting passage of large boilers and other high loads. These bridges are operated by hydraulic rams, inclosed in the columns, and illustrations of this form of bridge may also be found in Vol. CXVII of the Proceedings of the Institution of Civil Engineers.

A. G. Lyster, Esq., chief engineer of the Liverpool docks, extended every facility for seeing the various types of movable bridges about the Liverpool docks. None of the bridges seen here are specially suggestive for the purpose of the present study, although two of them may be referred to briefly as of historical and general interest. The first was a bascule bridge, figure 1 (very old) of the drawbridge type, which has a platform at the street level, with towers at one side, and with chains passing through the top, as per sketch, figure 1, in which A is the bridge plaform hinged at E, and B is a post of such height that the chain D makes an angle with the posts of about 45 degrees. C is a braced wrought-iron box-post, through which the chain passes down to the hydraulic operating machinery below.

Another bridge at the Liverpool docks which may be briefly referred to is illustrated in the sketch, figure 2. We have here an example of a bridge which is first lifted bodily from its seat to the level of the roadway, after which it is run back on the track leaving the dock-slip entirely clear, as illustrated in the sketch. The machinery for accomplishing this is operated by hydraulic power, the same as in the previous cases.

Probably the most interesting of the recent bridge construction, on a large scale anywhere, is the Tower bridge over the Thames, at London, the formal opening of which occurred as recently as June 30, 1894, and while this great bridge with its side suspension members, and its draw opening, with a clear span

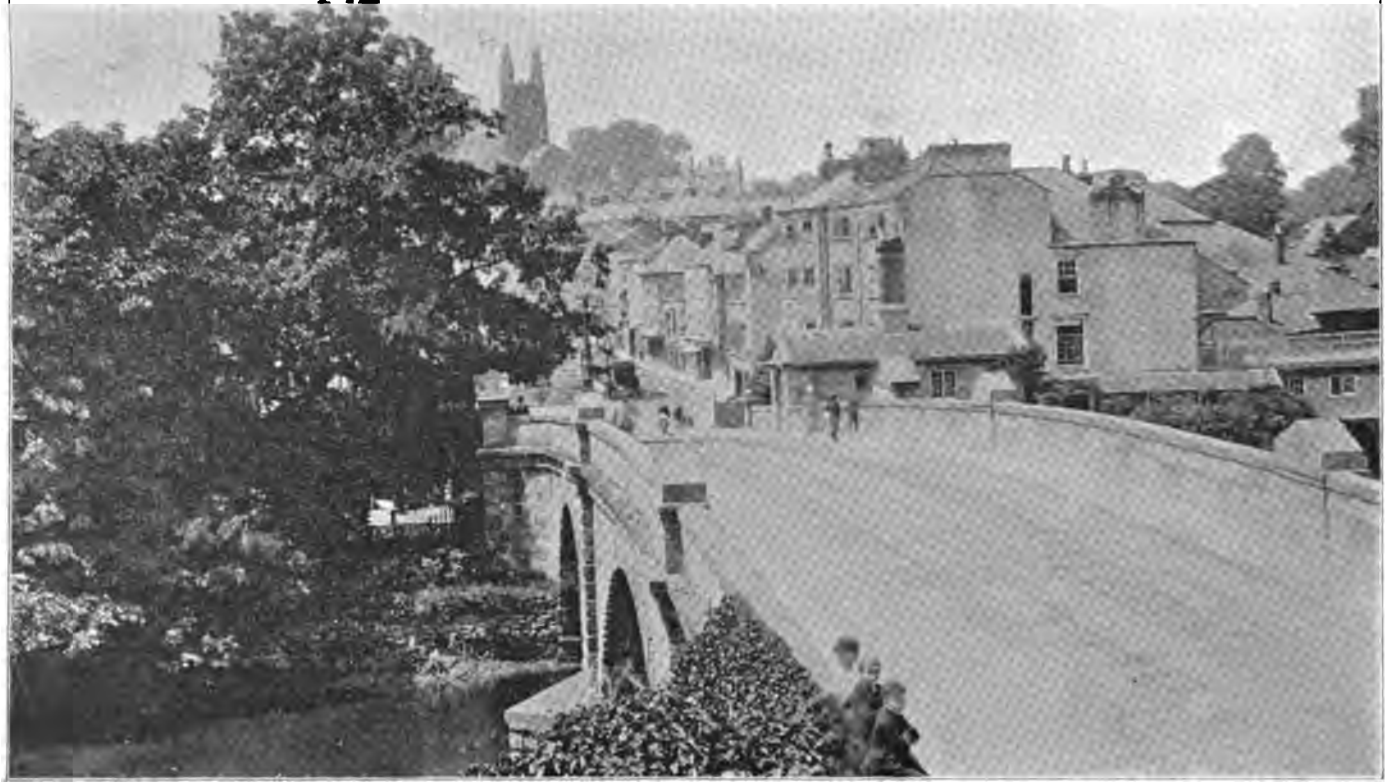

PLATE V.—AN ENGLISH STREET, WITH LONG GRADE APPROACH.

PLATE VI.— HIGHWAY CROSSING OVER CANAL IN ENGLAND.

PLATE VII.— HIGHWAY BRIDGE OVER MANCHESTER SHIP CANAL.

PLATE VIII.—THE TOWER BRIDGE WITH BASCULE CLOSED.

of 200 feet, and a total length of the entire bridge of nearly 1,000 feet, is far beyond any possible requirements of the Erie canal, nevertheless, by reason of embodying the most recent example of bascule construction on a large scale it may still be worth while to consider some if its main features in the present connection. It is especially interesting in any study of English movable bridges, because as already pointed out, hitherto horizontal swing bridges have been almost exclusively used in that country, but, at the Tower bridge a radical departure from the general rule of English movable bridge construction has been made, with the result of producing the largest, and on the whole the best example of the bascule principle thus far carried out anywhere. In this form of construction, the bridge and moving parts are made to swing in a vertical instead of a horizontal plane, the original conception of such a bridge dating from very ancient times, when, as a means of defense, a bridge formed by a single leaf of framed timber was used for crossing the mote of a fortress, and was made capable of being drawn up by chains from the inside in such manner as to render the ditch impassable, and at the same time blocking the entrance gate.

Plates VIII, IX, X and XI illustrate the bascule of the Tower bridge in various positions. Bridges of this class have also been constructed in England, at Hull and in a few other places; and also at Cork in Ireland. The most imporant bridge of this class in England, previous to the construction of the Tower bridge, was the one carrying the Northeastern railway over the River Ouse, at Selby. This bridge had a clear span of 45 feet, and was erected in 1839. It is stated to have always worked satisfactorily, although recently replaced by a swing bridge.

There are also in England a few hydraulically operated lift-bridges, for the purpose of carrying steam railways over canals, but none of them embody anything of special interest to us, over what is shown in the French bridges referred to further on in this report.

In Holland, somewhat different conditions are found from those in England. The surface of the country is so flat that economic considerations lead to the use of devices for keeping

the street surfaces in the more important streets of large towns as nearly level as possible. The use of movable bridges has, therefore, been quite common, especially in those towns with extensive canal developments, as for instance Amsterdam, Rotterdam, etc., for the last 100 years. Some of the older forms of movable bridges are shown in plates XII and XIII, photographed from structures still in existence and in use. Indeed, one sees this form of bridge very common in the cities and large towns of Holland. At Amsterdam and Rotterdam, however, an improved bascule has been used. It is common to lithograph the plans of public works intended for letting in Holland, and the directors of the public works of the cities of Amsterdam and Rotterdam have furnished me with lithographic copies of the plans of a number of bascule bridges actually erected in these two cities, from which plates I, II and III have been prepared. As used at Amsterdam, these bridges are commonly arranged with reference to operation by hand, while at Rotterdam, a somewhat larger and heavier design has been adopted which necessitates the application of special hydraulic machinery for convenience of operation. This machinery is operated by the ordinary pressure from the city water mains, which in the central part of the town averages about 25 to 28 pounds. Each half of the bridge has its own independent cylinder, with duplicates on each side, so that in case one cylinder is out of order the reserve cylinder may be immediately coupled, thereby avoiding the possibility of the bridge being out of service by reason of failure of machinery. These hydraulic cylinders are coupled direct to the crank of each half of the bridge, as shown on plate III.

Amsterdam is the great canal town of the north of Europe. According to the official list there are about 340 bridges of all kinds in that city; a few of these are over the river Amstel, but the great bulk are over canals. Of the total number 21 are bascules, 20 of which are operated by hand, and one by hydraulic power, applied in a manner similar to that shown on plate III. Of the old pattern of drawbridge bascule, shown in plates XII and XIII, there are 10; of swing-bridges, 16; while the balance are fixed bridges of various sorts and kinds.

The one large hydraulicly operated bascule at Amsterdam is a single span, in one of the bridges over the river Amstel, where it is necessary to leave an opening for the passage of boats.

In one case there is a bascule bridge at Rotterdam which, having been built before the city water mains were extended to it, an ordinary gas engine is used to first produce the hydraulic pressure, which is then applied from an accumulator by means of cylinders, similar to those shown in plate III, to operate the bridge.

At Rotterdam, the same as at Amsterdam, there are also a number of swing-bridges in use, but at both cities the swing-bridges are being superseded by bridges of the bascule type. At both places the engineers are of the opinion that bascule bridges are far superior to swing-bridges, not only because they can be operated more quickly, but because they are less liable to derangement of the operating mechanism. The bascule as used there can be opened in about 20 seconds.

At Rotterdam, the bascules are generally provided with gates across the streets, which are closed by the attendant before the bridge begins to open.

The force of attendants for hydraulically-operated bridges is four men, in all. Two being on duty during the day, and two at night. This provides at all times a separate attendant for each leaf of the bridge.

As constructed at Amsterdam, in accordance with the plans shown on plate II, the cost of the superstructure is about $6,800, while the substructure, including foundations, masonry and approaches, is about $14,000 to $15,000, making the total cost of these bridges at Amsterdam from $22,000 to $23,000. At Rotterdam, the cost of the heavier bridge used there is somewhat more; as an average, we may say the superstructure and operating machinery cost about $11,000. Generally speaking, the foundations are very expensive in the Holland towns, and vary in cost greatly, in proportion to the difficulties met with. In some cases the substructures of the bascule bridges at Rotterdam

have cost as much as $25,000 to $30,000. These figures, however, can not be taken as in any way a guide for work along the line of the Erie canal, where the conditions are generally quite different.

Some of the hydraulically-operated bascule bridges inspected at Rotterdam have been in use for over 20 years, and during that time have required little or no expenditure for repairs. These are operated during the entire 12 months of the year, probably with an average number of openings of from 30 to 50 a day, the number varying with the season of the year, the state of trade, etc.

Bascule bridges have been used in several other European cities, as, for instance, Stettin, Berlin and Havre, etc., and so far as information can be obtained, they have worked satisfactorily. There are seven or eight of them in the city of Copenhagen. The most important one there, having a span of 60 feet, and two moving leaves, worked by hydraulic machinery, was completed in 1869. This bridge also has hand-gearing and machinery driven by compressed air for use during the winter, when hydraulic power is not used. The time actually consumed in opening and closing the bridge is about one minute, but when done by hand-power it takes about half as long again. The average number of vessels passing through this bridge per day is 20, although as many as 55 have passed in a day; the aggregate interruption of the road traffic at such a time amounting to three and one-half hours. The maximum daily traffic over the bridge is 500 vehicles and 3,500 foot passengers. The annual cost of working this bridge is reported to be about $2,000.

The general plans and specifications of the bascule bridges, as built at Amsterdam and Rotterdam, and transmitted herewith for the information of the department, show so clearly the details of these bridges that it is unnecessary to refer to them at greater length here. It may, however, be pointed out that, with certain slight modifications of detail which is not necessary to go into extensively in a general report of this character, this form of movable bridge may be made applicable to the peculiar

PLATE IX. — ANOTHER VIEW OF TOWER BRIDGE WITH BASCULE CLOSED.

PLATE X.— TOWER BRIDGE WITH BASCULE PARTLY OPEN.

PLATE XI.—TOWER BRIDGE WITH BASCULE FULLY OPEN.

PLATE XII.—OLD FORM OF SINGLE BASCULE BRIDGE AS USED IN HOLLAND.

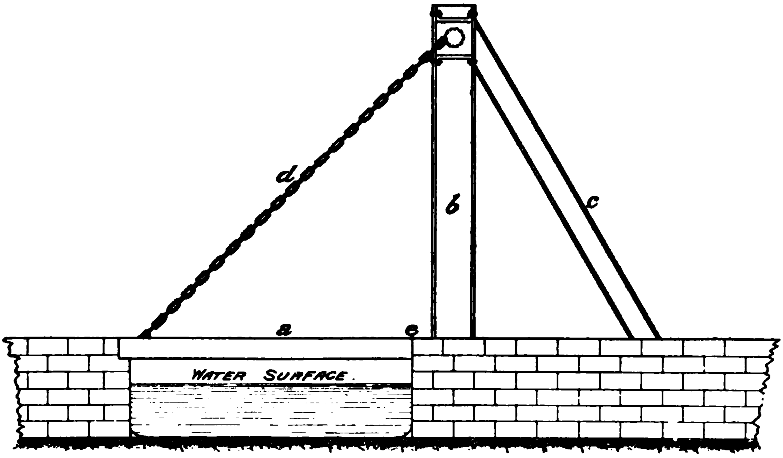

FIGURE 1.—SINGLE LEAF BASCULE AT THE LIVERPOOL DOCKS.

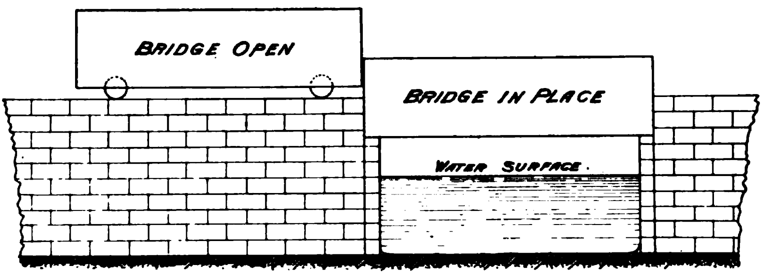

FIGURE 2.—ROLLING BRIDGE AT THE LIVERPOOL DOCKS.

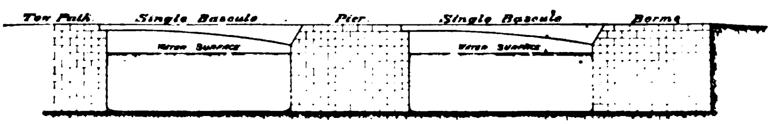

FIGURE 3.—SUGGESTION FOR BASCULE ADAPTED TO THE ERIE CANAL.

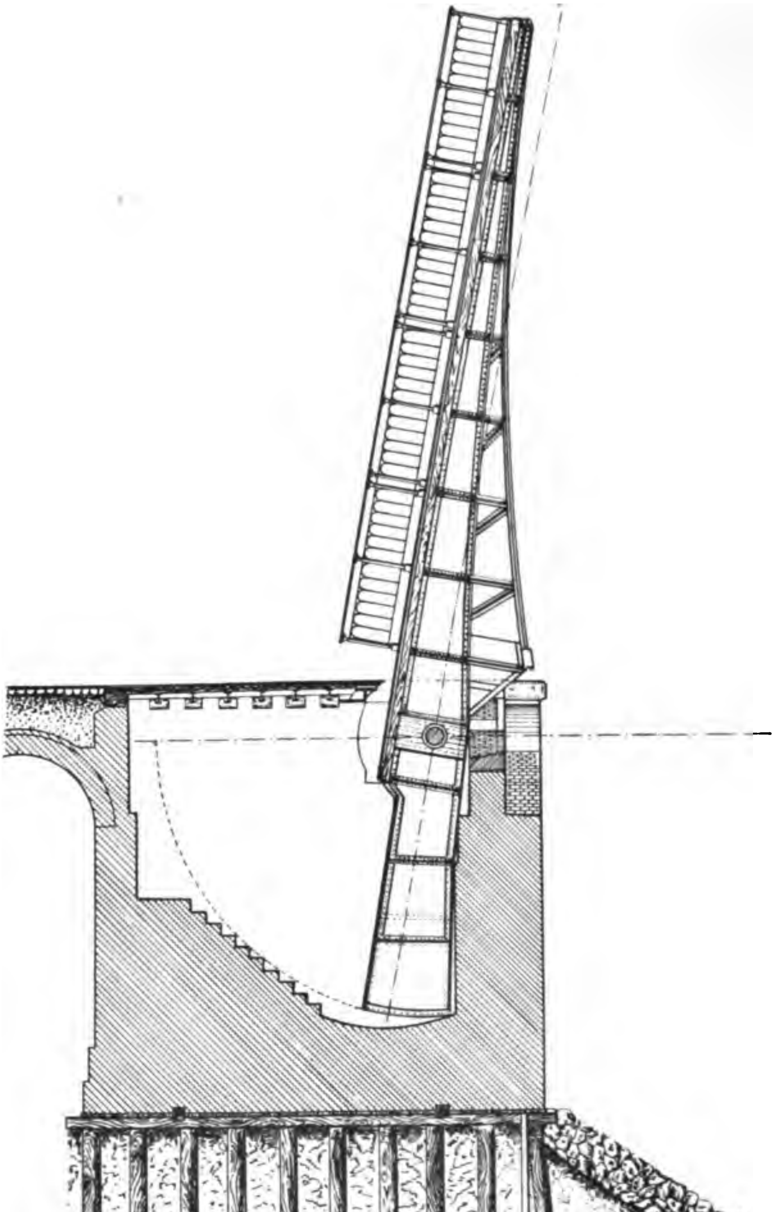

FIGURE 4.—AN OPEN BASCULE.

conditions existing at several points on the line of the Erie canal, and, probably, by its use, greater improvements made in the appearance of the city streets than by the use of any other form of bridge thus far devised. Its merits in this direction are sufficient to justify a study of its possibilities by engineers charged with the design of improved bridges for the State canals.

It may be objected to bridges of the bascule style that they make no provision for the passage of the tow-line, and that consequently the tow-line must be disconnected from the boat and carried around the bridge every time one of these structures is passed. A moment's reflection, however, will show that these objections need have no weight, because it is not necessary to build these bridges on just the plan which has been followed in Holland, and in the Tower bridge at London, of having the two leaves of the bridge hinged at opposite sides. The Erie canal is wide enough to permit of the location of a central pier in the middle of the channel, somewhat similar to that used in the present type of swing-bridge, although narrower, with one of the leaves hinged on the central pier, and the other hinged on the berme side of the canal, in this way avoiding all trouble with the tow-line. Figure 3 illustrates how such an arrangement can be made. Or, on the other hand, the leaf on the towpath side may be made to span the towpath also.

On this head, it may be further remarked that it is a mere question of time when the towing of boats on the canal by horses will be entirely done away with. The use of steam is increasing every year, while there is further a general feeling that electrical traction will be very soon found applicable to this class of work. It is worth while to consider, therefore, how far the plans of any new bridge need to be modified with reference to a form of boat propulsion which is rapidly passing out of use.

As regards West Main street, in the city of Rochester, the angle at which the street crosses the canal is such as to render the bascule type of bridge inapplicable, if erected on the lines of the street. The only way in which this type of bridge could

be applied to that locality would be by the adoption of a plan of crossing quite similar to the one in use at that point, when the single swing-bridge, which was removed to give place to the present mechanical lift-bridge, was there. In order to apply the bascule, it is necessary that the crossing be made either at right angles, or nearly at right angles.

One difficulty at West Main street with the single swing-bridge was the lack of space in which to make necessary curves for the street railways, and this difficulty would still exist in case of the construction of a bridge of the bascule type at that point, unless it were seen fit to acquire a considerable additional area for public use over that now existing there. If, however, this were done, a design for a bascule bridge could be prepared which would easily make this by far the finest public place in the city of Rochester. The acquiring of this additional space would naturally devolve upon the city of Rochester.

In France, we have the most notable example of a thorough system of inland water navigation of any in the world, the total length of the canals being about 3,000 miles. They are mainly owned by or are under the control of the State, and in their general management are probably more like ours than the canals of any other European country. As regards bridges of the kind now under discussion, the same practice has been followed there as in England, namely, generally speaking, fixed overhead bridges have been used in preference to any form of movable bridge. Within recent years, however, a few movable bridges have been erected in localities where there are exceptional reasons for keeping the grades of the city streets at or near the water level in the intersecting canal. One of the most interesting of these bridges, which was built in the Rue de Crimee, in Paris, in 1886, is illustrated in plate IV. A bridge on this general outline was erected during 1894, at Clinton street, Syracuse, which is said to operate very satisfactorily. That bridge may be criticised in this, that the corner posts are less attractive than in the original French bridge, which has apparently furnished

the basis of this design. The suggestion is ventured, that, in this particular, it would be quite possible to give the design such architectural treatment as would considerably improve on the original French model. The bridge in the Rue de Crimee is described at length in a paper on the reconstruction of the basin of La Villette, and of the St. Dennis canal, which appears in the Annales des Ponts et Chaussees, for May, 1886. At that time there were but two lift-bridges in France, and the author of the paper, M. L. Le Chatelier, engineer, of Ponts et Chaussees, begins his paper by a short account of the existing types of lift-bridges. In regard to the mechanical lift-bridges, of the United States, Mr. Le Chatelier comments as follows:

"A certain number of lift-bridges have been constructed in the United States during the last few years; they are all of a common character. Above the position of maximum elevation of the platform there is established a metallic framework which carries the mechanism; this mechanism is composed of shafts carrying pulleys, over which pass fixed chains, with one end attached to the bridge platform, and the other to counterweights. All parts of the mechanism are moved simultaneously by either a steam, gas or water motor, carried, also, on the framework; the synchronism of movement of all the points of attachment is assured by the similarity throughout of the mechanism.

"The arrangement of these bridges is inelegant from every point of view, and the disposition of the metal which it necessitates can not be justified either by the momentary course of the movement or the means of employing it.

"At Paris the circumstances are not the same, and the esthetic tastes of the public are different. Under these conditions it was necessary to abandon existing types; a succinct statement of the problem of which a solution was required was accordingly drawn up and forwarded to a number of bridge designers. Fives-Lille were the only firm which responded with plans, and it is their project which has been carried out."

The author then proceeds to describe the special points of the accepted design, but inasmuch as the Annales des Pont et

Chaussees is readily accessible at the State library, I will not consume space by reproducing the description in detail here. An idea of the general appearance of the bridge may be obtained from the reproduced plans of plate IV, which is all that is required at this time, except it may be stated that the movement of the bridge is assured by two hydraulic pistons, placed one under each end. At Paris, water, under heavy pressure from the mains of a hydraulic power supply company, is used, but there is no reason why the necessary pressure can not be obtained from the ordinary city mains in localities where water under heavy pressure is not available. With less pressure, however, a larger area of piston would be required. The French engineers stated that the bridge in Rue de Crimee had been thus far operated without any expenditure whatever for repairs.

In the Annales des Ponts et Chaussees for August, 1893, may be found a description and plans in detail of the lift-bridge of Larrey, which is situated upon the Bourgogene canal in the midst of the most important commercial and industrial district of the city of Dijon. This bridge was erected in the summer of 1890, and takes the place of a stone bridge constructed about the beginning of the present century. The reason for a change from a fixed bridge to a movable bridge at this particular place are given at length in the paper by Mr. Galliot, engineer of the Ponts et Chaussees, to which reference has been made. As in the case of the bridge at the Rue de Crimee in Paris, this bridge is lifted by hydraulic cylinders, as shown on the plans.

The plans of this bridge are given in considerable detail in the Annales des Ponts et Chaussees for August, 1890, and may be referred to by anyone interested. They embody a large amount of detail, especially as regards the arrangement of the foot-bridge which may be profitably studied by our bridge engineers.

Venice was also visited with the hope that suggestions might be obtained for the building of somewhat more ornate foot-bridges than has hitherto been the custom along the line of the Erie canal. Aside from the Grand canal, however, the canals of Venice are very narrow — 15 to 25 feet is, perhaps, the average width. The Rialto bridge over the Grand canal is, of course,

PLATE XIII.—OLD FORM OF DOUBLE BASCULE BRIDGE AS USED IN HOLLAND.

PLATE XIV.—A MODERN BASCULE BRIDGE IN THE CITY OF ROTTERDAM, HOLLAND.

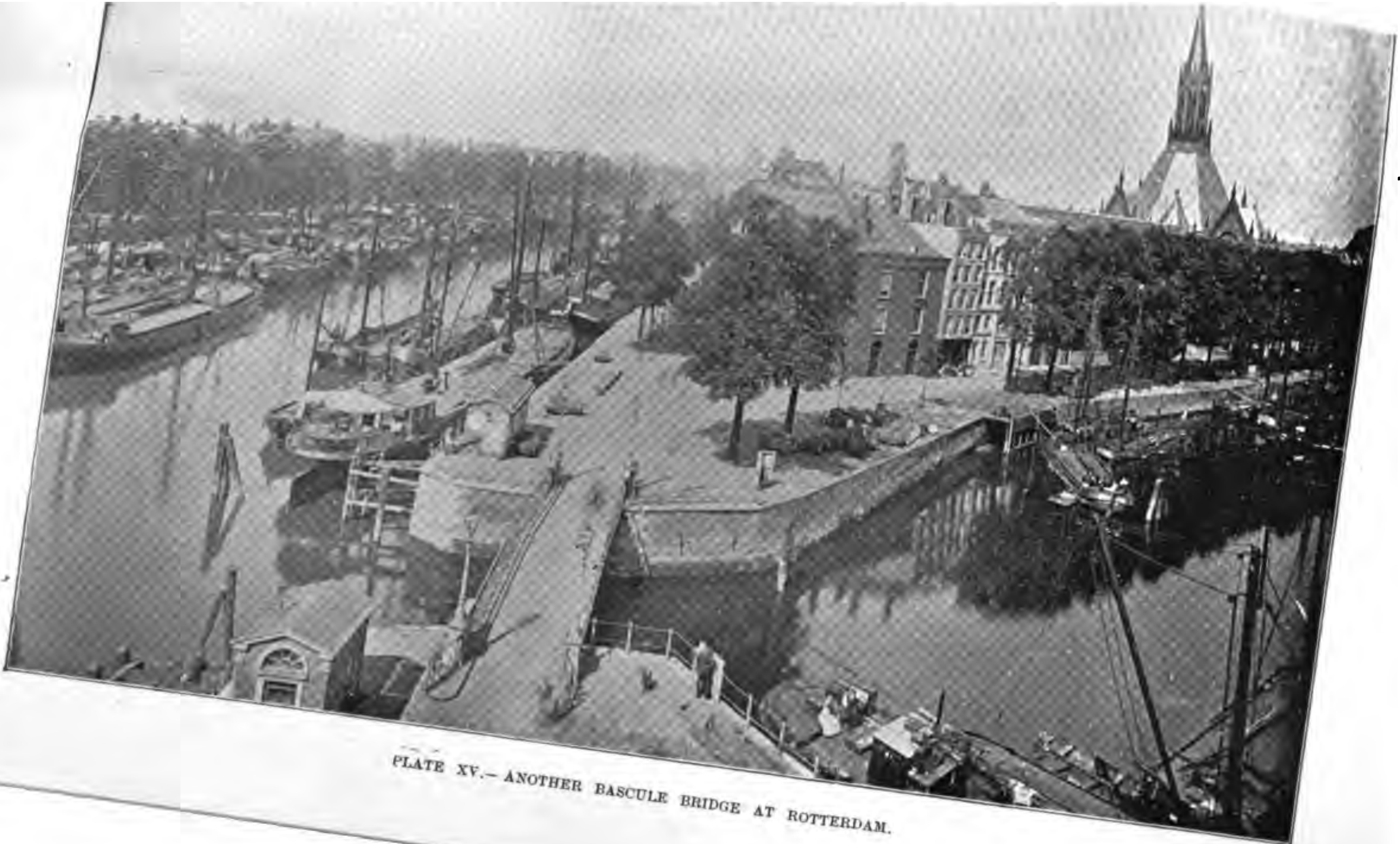

PLATE XV.—ANOTHER BASCULE BRIDGE AT ROTTERDAM.

PLATE XVI.—STREET SCENE IN ROTTERDAM. OPEN BASCULE BRIDGE AT LEFT OF CENTER.

PLATE XVII.—THE RIALTO BRIDGE AT VENICE.

PLATE XVIII.—FOOT BRIDGE AT THE DOGE'S PLACE, VENICE.

PLATE XIX.—AN ORDINARY VENETIAN FOOT BRIDGE.

one of the famous historical bridges of the world, and while hardly suitable as a model for copying, is still very suggestive if anyone desired to design a foot-bridge over the canal with special reference to architectural features. It is illustrated by plate XVII.

The other bridges of Venice are of a common character, and fairly illustrated by plates XVIII and XIX.

The foregoing account of movable bridges, as applied to inland canals in European countries, gives, it is believed, a fair idea of the state of the art in those countries at the present date. As we have seen in both England and France, the fixed overhead bridge is preferred, in all places where that form is applicable, to any style of movable bridge whatever. In Holland, however, where the extreme flatness of the country has rendered it desirable to avoid even moderate grades, in busy city streets, movable bridges have been somewhat more extensively used, although it should not be overlooked that, even in the cities of Holland, fixed bridges greatly preponderate. It appears to be generally recognized, even there, that movable bridges are somewhat of an obstruction to both navigation and street traffic.

As a summation of the studies of movable bridges in Europe, we may say:

(1) That probably the most important point brought out is that the European engineers, by studying each case on its merits, have succeeded in working out the proper solution.

(2) It is also clear that, generally speaking, the European engineers have succeeded in securing much better work on all the bridges examined than is customary on State work here.

(3) It appears from the examination of current European practice, that, with good workmanship assured, almost any rational design of mechanically operated bridge may be made satisfactory. Therefore, as far as American designs of movable bridges are concerned, the chief question to settle is what form of mechanically operated bridge can be best constructed with reference to each specific case, and at the same time the best results attained with reference to a tasteful appearance of our city streets.

(4) We must not overlook, however, that, in Europe, the great trend of engineering opinion is clearly in favor of fixed overhead bridges wherever they are applicable, rather than for the use of any form of mechanically operated bridge whatever.

As regards the State of New York, therefore, the problem takes the form of a determination of what is the best thing to do with reference to all the interests involved in each particular case. In attempting to arrive at a solution, we may now again take up the consideration of the various propositions which have been made for an amelioration of the difficulties existing at West Main street.

Let us examine a little in detail as to the effect on the traffic of any busy street on which one of the movable bridges may be located of greatly increasing the number of boats now moving on the Erie canal.

According to the navigation statistics, given in the annual reports of the Superintendent of Public Works, it appears: (1) That September and October are usually the months of greatest movement; and (2), that in an ordinary year we may expect, during those months, an average daily movement of boats in both directions of about 100. From actual observations made by the present writer at West Main street bridge, it appears that the average detention of the street traffic, per boat passing, is between four and five minutes; or, we may say that under the existing conditions and taking into account the through movement only, the traffic of the street is interrupted in September and October somewhat more than seven hours out of every 24. Moreover, the above statistics as to daily movement do not represent the purely local movement of boats in any large city where there must necessarily be more or less local passing back and forth of boats from dock to dock. Making some allowance for such, and we conclude that in the busy months, even with the present traffic, the interruption of the street traffic at one of these movable bridges may amount to as much as eight hours daily, or to one-third of the total of every 24 hours.

But there is another consideration. The foregoing discussion proceeds on the tacit supposition that the daily movement is

equally distributed throughout the whole 24 hours. If this were true, then the total interruption of street traffic would be much less serious, because the street traffic on many business streets with large movement during the working hours, is almost nothing at night. A moment's reflection, however, renders it clear that there is in general much greater movement of boats during daylight than at night, hence a large portion of the interruption of the street traffic occurs at that time of day when it is most important that it should be uninterrupted. In the absence of statistics it is impossible to say just what the proportion of day to night movement of boats on the canal really is, but, as a matter of judgment, taking into account the local movement back and forth, from dock to dock in the large cities, and it appears reasonable to assume about two-thirds of the total movement by daylight and one-third at night.

We have already seen that what we may term the total daily through movement of boats amounts, under present conditions, to an average of about 100 boats per 24 hours. Adding to this somewhat, for the local movement back and forth in the large cities, and we may have a maximum total daily movement of all classes of say 120 boats.

Taking two-thirds of this as occurring during the working hours, and we find further that we may expect 80 interruptions of street traffic, of say an average length of four and one-half minutes each, to occur during the working portion of the day, or the total interruption of street traffic during the working hours of each day of the busiest navigation months may amount to about six hours.

Again, the average length of the day in October, from sunrise to sunset is about 11 hours and 10 minutes; hence it is concluded, that even with the present movement of boats there may occur an interruption of the street traffic during each day of the busiest months equal to more than one-half of the total daylight period. This, of itself, is serious enough, but if we further take into account such considerable increase in size of tows and number of boats passing, as may be expected to result from the

proposed enlargement, it becomes clear that the time may soon arrive when in the large cities the street traffic would be nearly totally suspended, during the working hours, on all streets crossing the canal by movable bridges.

Some discussion has ensued at various points on the line of the canal as to what proportion of the gross expense of fixed bridges should be borne by the State, in case any of the movable bridges were to be removed and fixed bridges substituted in their place. In answering the question thus raised, let us examine the question from several different points of view.

In the first place, it appears evident that the State owes it to the navigation interests to so manage the Erie and lateral canals that navigation may be free from vexatious and possibly damaging interruptions, such as may be expected to occur at any of the city streets now crossing the canal by movable bridges, provided the traffic of such streets should greatly increase beyond the limit of time which has been shown to be available by the preceding discussion. Thus far, in the history of movable bridges, as applied to the State canals, the street traffic has waited upon the navigation, although it is clear, if the traffic of the streets were to greatly increase, and at the same time navigation were to remain stationary, or nearly so, there would probably be a demand on the part of the citizens of the inland cities for such an administration of the canals as fitted the new conditions of things.

Again, equally, the State owes it to those citizens who, while not directly interested in navigating the canals, are still, as residents of the inland cities, compelled to cross the line of the Erie canal from day to day, and whose business interests are naturally injured by the constant interruption of the street traffic which must occur on all the streets fitted with movable bridges, that the injury be reduced to a minimum, or, if practicable, that there be no injury at all — as otherwise we find the State in the position of oppressing one class of business enterprises for the benefit of another class, a position which thus far has been foreign to the policy of the canal department of the State of New York.

If we examine as to the cash value of the interruptions of street traffic during the navigation season of seven months per year, we find, in the case of a highway like Exchange street, in the city of Rochester, the following to represent the approximate fact:

We have already seen that in September and October the interruptions may easily amount to as many as 80 per working day. This figure would, however, be somewhat high for the whole navigation season of seven months, from May to September, inclusive, and for the whole period we will say an average of 50 interruptions per day, during daylight, thus throwing out of account all interruptions of street traffic which occur at night. We will also further throw out of account all interruptions occurring on Sunday, and base the computations on the 180 working days of the seven months of the navigation season. The average interruption on Exchange street may be taken as interfering with the business movement of at least 100 vehicles and foot passengers, all told. For lack of definite statistics taken on the ground, we have no way of determining the average relative number of vehicles and foot passengers, but it is certain that the number of drays and other vehicles is large. We are undoubtedly far within the truth if we say that the time of all classes of passengers, including drays and other vehicles, who suffer interruption on this street is worth at least $2 per day. With 50 interruptions and an average of 100 people hindered at each interruption, for a period of four and a half minutes, we have a total loss of time on each day of 22,500 minutes, or of 37.5 working days of 10 hours. At $2 per day for all classes of persons and vehicles kept waiting, the loss of time amounts, then, to $75 per day, and for 180 working days in the navigation season, we find an annual gross sum of $13,500, which those citizens of the State who use Exchange street are either deprived of or compelled to pay unnecessarily by reason of the interruptions to their ordinary business engagements resulting from the operation of the movable bridge now in that street.

It is no part of my intention to argue that the present movable bridge in Exchange street should be removed, and a

fixed bridge substituted. This street is merely selected for illustrative purposes, as one whereon the street traffic has outgrown the present means of accommodating it, and where some kind of change in the way of better accommodation of the street traffic is imperatively necessary. As between the people of the State, however, and the canal department, it is pointed out that the State may justly expend in remedying difficulties of the sort now under consideration, in each case, the sum of money which capitalized at the current rate of interest for perpetual loans would produce an annual interest equal to the fair annual loss to the people of any locality where these movable bridges have been erected. In the case of Exchange street, this annual loss is shown to be at least $13,500, which, capitalized at 4 per cent., amounts to $337,500; that is to say, the State may properly expend the sum of $337,500 in any permanent work which will effectually remove the obstruction to the street traffic which now exists during seven months of each year on that street.

If such improvement took the form of properly-designed fixed bridges with long, easy grades, it may be pointed out that the best interests of not only the people using the streets, but equally the best interests of those navigating the canals would be conserved.

In presenting the foregoing considerations, it is not overlooked that there are some localities where fixed bridges are not now applicable, and for such the only remedy is the construction of the best form of movable bridges.

As regards the loss of time suffered by the citizens of any town where movable bridges are used, the foregoing general discussion has not taken into account an additional serious element of loss which there is no way of estimating even approximately, namely, business men with definite appointments, workmen on their way to work, and people taking railway trains are obliged to be at their various destinations at the minute. The uncertainty as to whether the movable bridge will be open or closed, leads everyone using these bridges to make a larger allowance of time for safety in keeping appointments than would

otherwise be necessary. The total annual loss of time from this source, while not susceptible of exact determination, must still be very large.

In concluding the report, it may be remarked that, aside from the various forms of movable bridges herein described as in use in Europe, there are probably several other forms of movable bridge which are entirely practicable, and which American engineers may be expected to successfully work out when given an opportunity. This report has been properly confined to the several forms of bridges used abroad, the consideration of anything outside of that not being within my instructions.

Respectfully submitted.

GEO. W. RAFTER.

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